MACHINERY.

October, 1903.

A SCREW PROPELLER PLANING MACHINE.

Fig. 1. Model of a Ship's Hull under Test.

THE machine of which an illustrated description is published herewith, is entirely novel in conception and design and in the work that it performs. It was designed for planing the blades of screw propellers, to be used for experimental purposes, and will accurately finish helicoidal surfaces of any desired pitch, within reasonable limits and with the pitch either uniform or variable. The machine was built for the United States Government by the Builders Iron Foundry, Providence, R. I., and is now in use at the Washington, D. C., Navy Yard as an adjunct of the experimental model-testing basin located there, where models of vessels are tested to determine their performance at various speeds.

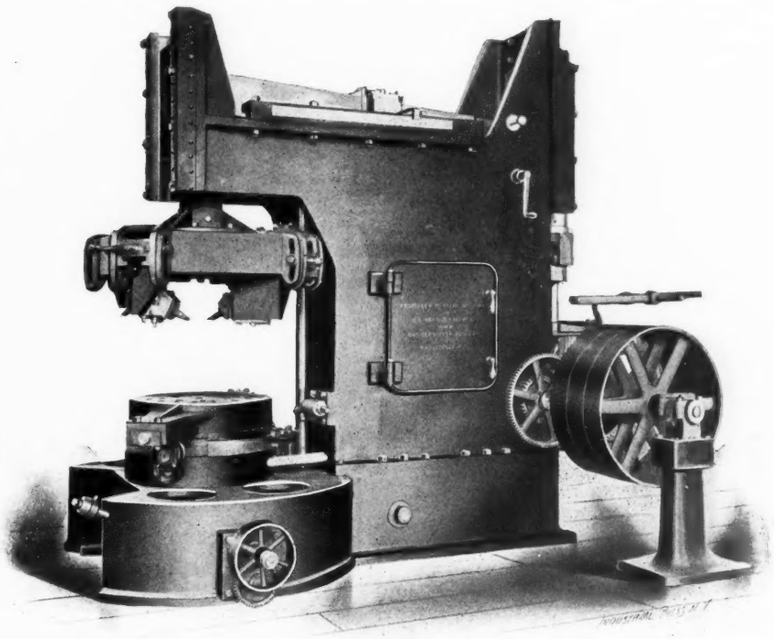


Fig. 2. Propeller Planer for Machining the Blades of Propellers for Experimental Purposes.

The experimental model basin was completed between two and three years ago, and tests upon models of ships of various types have since been regularly conducted. The building in which the basin is located is 500 feet long, and 50 feet wide, while the water surface of the tank is 470 feet long. The basin is spanned by a bridge which travels on carefully leveled tracks at the side of the basin and is driven by electric motors fitted with the Ward Leonard system of control, which permits an almost infinite variety of very uniform speeds. The model to be tested is placed in the water below the bridge and attached by a flexible connection to brackets extending below the bridge. The brackets support a dynamometric apparatus by which the resistance of the model is automatically recorded upon a drum placed on the platform above for the different speeds at which it is towed. The models are made uniformly 20 feet long and coated with smooth, white enamel. The process of making the models involves the use of several complicated special woodworking machines. As a result of one of the first series of tests changes were made in the lines of a model which were such an improvement that had the vessel been constructed along the old lines instead of in conformity with the new, it is estimated it would have required 2,000 horse power more to have propelled it at its maximum speed of 19 knots an hour than was required with the vessel as constructed.

The propeller models which the planing machine was built to produce are to be tested in connection with ship models in the experimental basin. Tests upon screw propellers have previously been conducted, either with full-sized propellers on full-sized ships—which is at best a slow and very expensive process—or with small propellers made to rotate in a fixed position in a tank of water, and driven by an electric motor or other power outside of the tank. Tests of the latter description have recently been carried on at the naval academy at Annapolis, and have been productive of good results, although the information to be derived from them is necessarily comparative rather than specific. Results that will supply definite data for a designer to work with can only be obtained by testing a propeller in connection with the hull of a ship, where there is always motion of the water around the stern, relative to the hull, which affects the action of both ship and propeller. It is proposed to test the propellers made on the planing machine by equipping a model hull with them and driving the propellers with electric motors, which will enable the power absorbed and the speed of rotation to be accurately determined; and from the results derived from such tests the performance to be expected from propellers and hulls on similar lines, but of full size, can be closely calculated.

The general features of design of the planer were outlined by the Navy Department and were original with Naval Constructor D. W. Taylor. The details of construction, however, were left with the builders and were worked out by Mr. F. N. Connet, mechanical engineer of the Builders Iron Foundry. The planer operates on rough bronze propeller castings of two, three or four blades, ranging from five inches to 24 inches in diameter and will finish both the fronts and backs of the

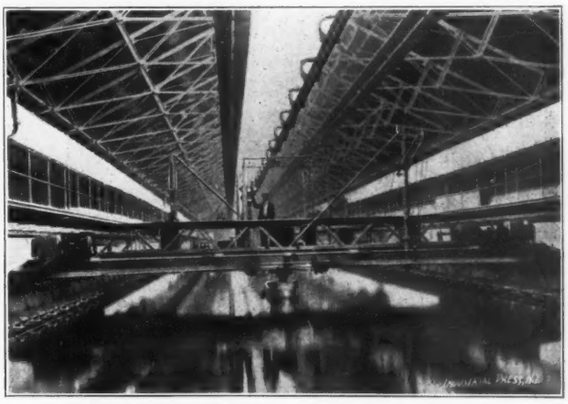


Fig. 3. The Marine Experimental Basin, Washington Navy Yard, where Screw Propellers are to be Tested.

blades. The cutting is accomplished by diamond-point or round-nose tools, the tools and work being given such relative motion as to cause the surface of the blade to have the required pitch and form. The propeller is mounted, with its axis vertical, upon a horizontal table, which has a reciprocating rotary motion about its vertical axis. The cutting tools are carried by a cutter head, which has a reciprocating motion in a vertical direction, timed to correspond with the motion of the table. Provision is made for varying the extent of the travel of the cutter head, relative to the motion of the table, by this means varying the pitch of the surface being planed. The machine is driven by a shifting-belt mechanism, similar to a planer of the usual type, the shifting mechanism, in this case, being controlled by dogs clamped in a T-slot on the periphery of the table. Both the cutter head and the table are operated by the same shifting belt, and the feed for the tools is operated by a planer feed mechanism, with friction clutch.

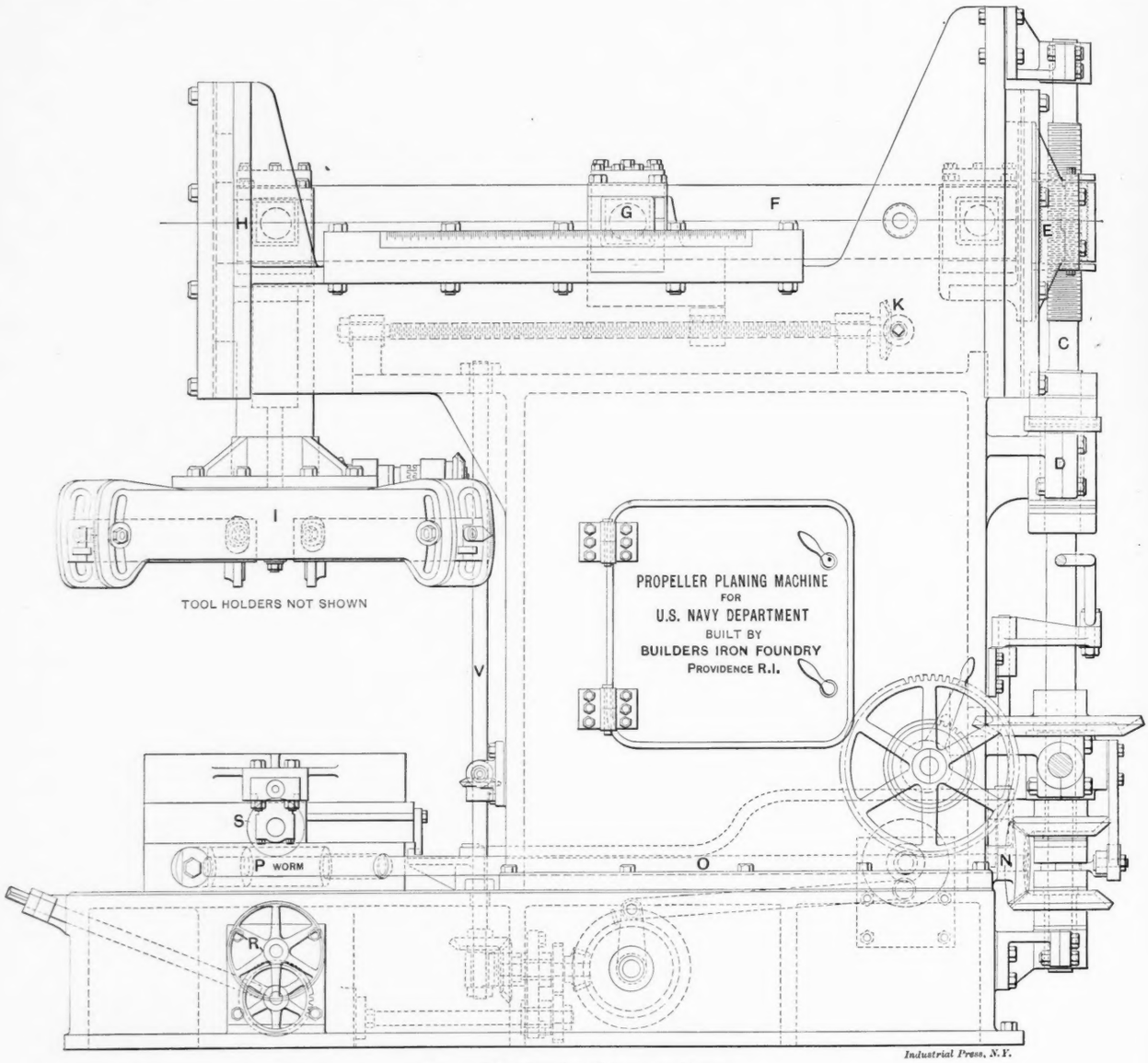


Fig. 4. Side Elevation of Propeller Planer.

In Fig. 2 on the first page is a side view of the machine and in Fig. 4 is a side elevation indicating many details of construction. The two subsequent views, Figs. 5 and 6, show details of the mechanism at the rear of the column and on the opposite side from Figs. 2 and 4. The belt pulleys are three in number, 30 inches diameter and 5-inch face, the two outside pulleys being loose and the middle one, *A*, in Fig. 6, is tight on its shaft and transmits motion through the bevel gears, *BB*, to the vertical driving shaft, *C*. This shaft consequently changes its direction of rotation with each reversal of pulley *A*, and the reciprocating motions of both cutter head and table are derived from it.

At the lower end of the driving shaft are bevel gears, *L* and *M*, Fig. 6, loose on the shaft, but either of which may be set in motion by a clutch which is splined to the shaft. These gears mesh with a third bevel gear, *N*, Fig. 4, and transmit motion through the shaft, *O*, to a worm, *P*, and worm-wheel, which drive the table, and give it its reciprocating motion. The object of the two bevel gears and clutch on the driving shaft is to reverse the direction of rotation of the table, relative to the motion of the driving shaft, so that either right- or left-hand propellers may be planed.

At the upper end of the driving shaft is a double-threaded screw, 3½ inches diameter, ¾ inch lead, which runs in an adjustable bronze nut, forming part of the crosshead, *E*. This crosshead is connected with the walking beam, *F*, Fig. 4, by a sliding and pivoted joint, and the walking beam, at its opposite end, is similarly connected with another crosshead carrying the tool head *I*. It is evident that in the production of the surfaces of a propeller blade the motions of the blade and tool are entirely analogous to the motions of the corresponding parts when thread cutting in a lathe. That is, for a propeller of uniform pitch, the propeller must rotate uniformly and the tool must advance uniformly, just as the work turns uniformly and the carriage and tool post advance uniformly in the case of the engine lathe. In the propeller planer the driving shaft has a uniform rotary reciprocating motion, received from the driving belt, as we have already seen, and this is reproduced

in the motion of the table through the bevel-and-worm-gear connections. The design of the walking beam, also, is such as to give a uniform advance and return to the cutter head, this being accomplished by the crosshead at each end, guided in a straight, vertical line, in connection with the walking beam, which is so arranged that each end slides in a block pivoted to the crosshead at that end. This arrangement maintains a constant ratio between the lengths of the two arms of the

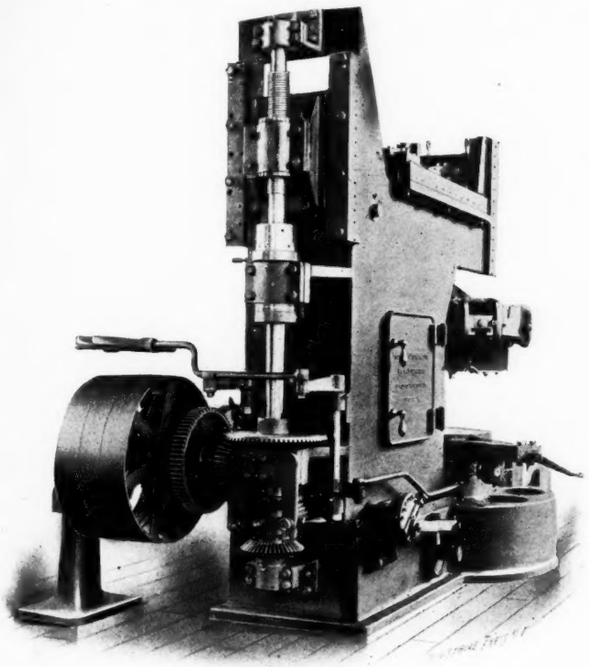


Fig. 5. View showing Feed and Driving Mechanisms.

walking beam, whatever the angle of inclination, and the motion of the cutter head thus accurately reproduces the motion transmitted by the screw at the upper end of the driving shaft, *C*.

The walking beam is a steel forging of rectangular cross section and has an adjustable fulcrum consisting of a trunnion block which can be clamped to the walking beam at any desired position along its length. This block has two trunnions supported in boxes carried by a casting which can be adjusted to any desired position by means of a crank, *K*, Fig. 4, a pair of bevel gears, and a screw. The adjustment of the position of the fulcrum varies the distance traveled by the cutter head, *I*, for each inch of travel of crosshead, *E*; and as the travel of crosshead *E* is always relatively the same as the travel of the table, it is evident that adjustment of position of the fulcrum of the walking beam enables propellers of various pitches to be planed. To facilitate setting the machine, the frame adjacent to the walking beam is graduated and indicates where the fulcrum must be set to correctly plane a propeller of given pitch. The maximum movement of crosshead *E* is 8 inches and the movement of the cutter head can be varied from 1 inch to 12 inches.

The work table of the machine is 27 inches in diameter and is arranged so that it can be raised or lowered either by hand or by power, to bring the work into position for machining. The gearing for this purpose is shown at *R*, in Fig. 4. Provision is also made for the automatic lifting of the table while the machine is in operation, through the use of two cam surfaces, bolted to the base of the machine, on diametrically opposite sides of the table. By raising the table during the downward, or cutting stroke of the tool, the effect is the same as though the cutting speed of the tool were changed, thus allowing the propeller to rotate a greater or less amount, according to the shape of the cam, for every inch of travel of the tool, and producing a propeller of variable pitch. By laying out suitable cams any desired variation in pitch can thus be obtained. There are two horizontal arms, extending radially outward from the table, as shown clearly in the half-tone illustrations, each of which carries a sliding block supporting a steel roll. These rolls ride up and down on the cam surfaces as the table reciprocates, alternately raising and lowering the

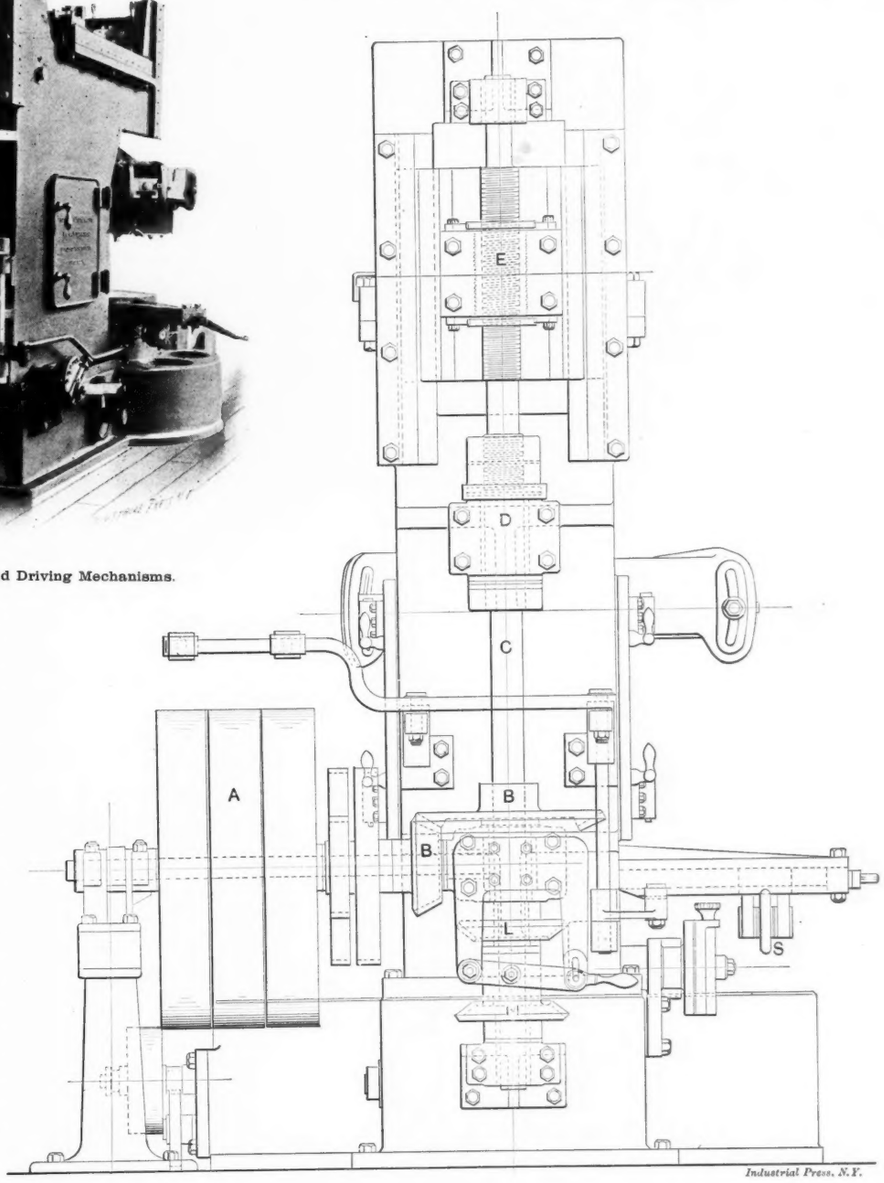


Fig. 6. Rear Elevation of Propeller Planer.

table. Provision is made for feeding the rolls out or in along the radial arms, their motion keeping pace with the out or in feed of the cutting tools; and by making the cam with a surface of changing curvature, different pitches can be employed for the inner and outer ends of the propeller blades.

In Fig. 7 is a view of the under side of one of the cutter heads. This head has four radial slots or channels, in each of which are slides or ways that carry the tool heads. The cutter head is designed for planing either two- or four-bladed propellers, and there is a second head having three radial slots spaced 60 degrees apart, for planing three-bladed propellers. The specifications for the machine called for the

feeding of the tools in a radial direction in a horizontal plane, and also the ways on which the tool heads traveled should be capable of being swiveled up to 10 degrees in either direction with the horizontal, the object being to provide for propellers having "rake" to the blades. The slides are pivoted at their inner ends and are clamped in position by two bolts at their outer ends. Each tool head carries a tool post attached to a swiveling apron, similar to the tool heads of planers and shapers, and two sets are furnished, one right-hand and one left-hand, for cutting right- and left-hand screws, and all of them have adjusting screws for vertical adjustment of the tools.

The feeds for the tool heads are derived from a central stud gearing with feed screws which extend radially one for each slide. The feed screws have universal joints at their inner ends to allow motion to be transmitted when the slides are tilted above or below the horizontal. The central feed stud derives its motion from the bevel gear seen on the outside of the cutter head at top of the engraving, Fig. 7, and this gear in turn meshes with a gear on the splined feed shaft, *V*, in Fig. 4. At the lower part of Fig. 4, the gearing connecting this feed shaft with the ratchet wheel operated by the friction feed mechanism of the planer is shown by dotted lines. The cam rollers on the table arms also derive their feed motion from the same device.

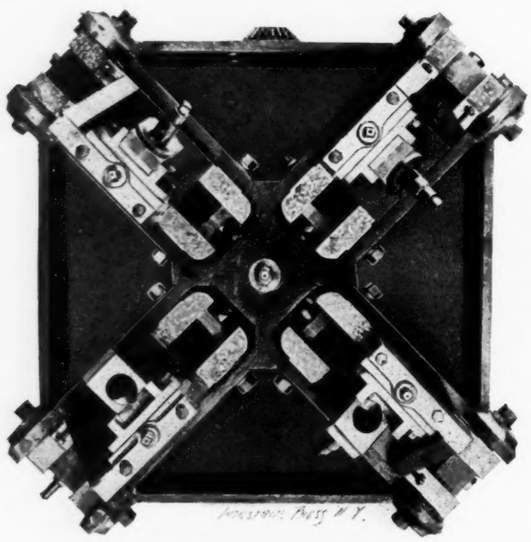


Fig. 7. View of Cutter Head from Underneath.

The machine is back-geared and is belted to a countershaft driven by an electric motor. It weighs about 10 tons, is 8 feet 10 inches high, 4 feet 10 inches wide, and 8 feet 3 inches long. It works to the entire satisfaction of the government officials and the builders.

Without doubt the installation of the propeller planer will result in the carrying out of many important and much-needed experiments upon screw propellers, and apparently we have started upon an era of scientific investigation in marine propulsion, and problems connected with it, which will give designers much better data to work with than any which now exist.

THE NEW SPRINGFIELD RIFLE, ADOPTED BY THE UNITED STATES GOVERNMENT.

The new Springfield rifle, model 1903, which has been adopted by the United States Government in place of the Krag-Jorgensen rifle, is a shoulder arm that, to date, is said to be without an equal in flatness of trajectory and penetrating power. Shooting at a range of 1,000 yards the maximum ordinate of the trajectory is only 20.67 inches high. That is to say, in a distance of 3,000 feet the parabolic path of the bullet curves upward less than 21 inches above the straight line connecting the muzzle and the point of impact. The initial velocity of 2,300 feet per second gives the projectile a

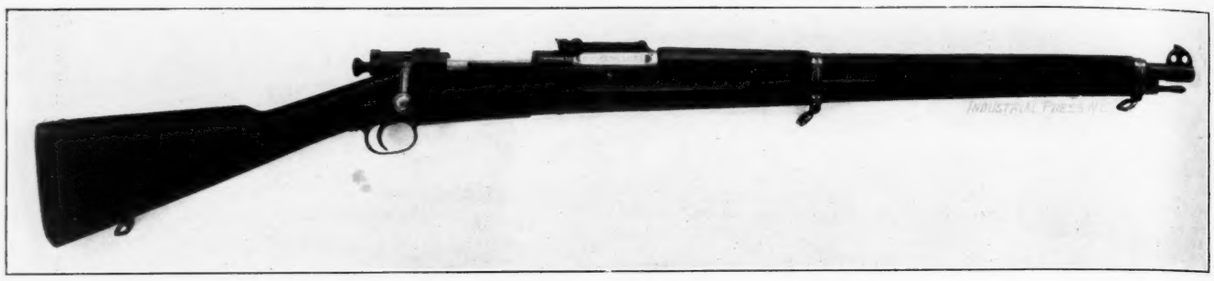


Fig. 1. The New Springfield Rifle—the best Army Rifle in the World.

penetration of 54.7 inches of white pine, the target being composed of 1-inch boards, 1 inch apart and located 53 feet from the muzzle. Since the energy required to penetrate the fleshy part of a man's body is about equal to that required to penetrate a 1-inch pine board, it follows that the new rifle theoretically has the power to mow down fifty-five men in a line at a distance of 53 feet from the muzzle.

The accompanying comparative table from the *Scientific American* gives the principal data for the new rifle, the Krag-Jorgensen which it displaces, the Mauser, and the German military rifle. The weight of the new weapon is 1.17 pounds less than that of the Krag-Jorgensen, but perhaps the greatest advantage is its short length, being only 43 inches as compared with 49 inches, the length of the latter. This length, which is slightly greater than that of a military carbine, will enable the arm to be used by both the cavalry and infantry, and it is expected that it will be adopted by the Navy Department as well, thus equipping all branches of the service with the same weapon and using the same ammunition.

NEW SPRINGFIELD MAGAZINE RIFLE COMPARED WITH THE KRAG-JORGENSEN, THE MAUSER, AND THE GERMAN MILITARY RIFLE.

	Springfield Magazine Rifle.	Service Magazine Rifle.	Mauser 7 mm. Rifle.	German Military Rifle.
Caliber, inches	0.30	0.30	0.275	0.311
Rifling: Number of grooves.	4	4	4	4
Rifling: Depth of grooves. inch.	0.004	0.004	0.0049	0.004
Rifling: Twist, one turn in, inches	10	10	8.66	9.45
Weight of bullet, grains	220	220	173	226.82
Weight of charge, grains	40.3	37.6	38.58	41 2
Weight of complete cartridge, grains	451.15	438.85	385.63	430.24
Initial velocity, feet per second	2300	2000	2200	2145
Remaining velocity at 1,000 yards	958	901	895	906
Muzzle energy, foot-pounds.	2581.6	1952	1857.4	2135
Striking energy at 1,000 yards, foot-pounds	447.9	396.2	307.4	413
Penetration in white pine at 53 feet, inches	54.7	45.8	50.8	..
Weight of rifle, including bayonet and scabbard, pounds	9.47	10.64	10.5	11.54
Weight of rifle, including bayonet, scabbard and 100 cartridges, pounds	15.91	16.91	16.8	17.68
Capacity of magazine, pounds	5	5	5	5
Maximum ordinate of 1,000 yards trajectory, feet.	20.67	25.8	24.47	23.73

Because of the general use of smokeless powder which has not only greatly widened the danger zone, but made close encounters practically impossible, the evolution of the military rifle will undoubtedly eventually end with the total discarding of the bayonet; in this gun it is reduced to a mere pike or rod bayonet. This rod normally lies underneath the barrel in the position ordinarily occupied by a cleaning rod or the ramrod of the old muzzle-loader. When required for action the rod bayonet is pulled part way out until a catch engages a circumferential groove.

The magazine holds five cartridges. Loading the magazine is effected by means of a clip holding five cartridges in a row, which is over the magazine with the breech open. Pressure downward forces the cartridges into the magazine where they

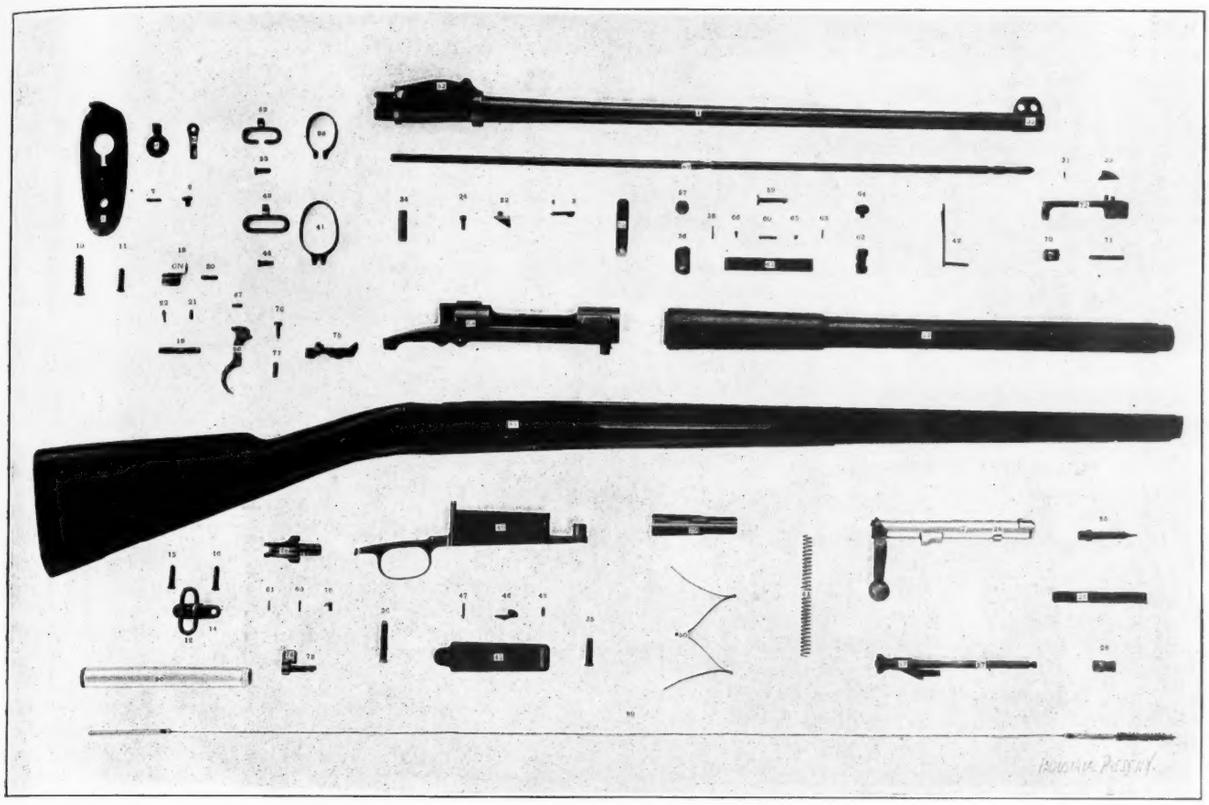


FIG. 2. COMPONENT PARTS OF SPRINGFIELD MAGAZINE RIFLE, MODEL 1903.

1. Barrel.
2. Bolt.
3. Bolt Stop Spring.
4. Bolt Stop Pin.
5. Butt Plate.
6. Butt Plate Cap.
7. Butt Plate Cap Pin.
8. Butt Plate Cap Spring.
9. Butt Plate Cap Spring Screw.
10. Butt Plate Screw—large.
11. Butt Plate Screw—small.
12. Butt Swivel.
13. Butt Swivel Pin.
14. Butt Swivel Plate.
15-16. Butt Swivel Plate Screws—two.
17. Cocking Piece.
18. Cut-off.
19. Cut-off Spindle.
20. Cut-off Spindle Screw.
21. Cut-off Spring.
22. Cut-off Spring Spindle.
23. Ejector.
24. Ejector Pin.
25. Extractor.
26. Extractor Collar.
27. Firing Pin.
28. Firing Pin Sleeve.
29. Follower
30. Front Sight.
31. Front Sight Pin.
32. Front Sight Stud.
33. Front Sight Stud Pin.
34. Guard Screw, Bushing
35. Guard Screw, Front.
36. Guard Screw, Rear.
37. Hand Guard.
38. Hand Guard Spring.
39-40. Hand Guard Rivets—two.
41. Lower Band.
42. Lower Band Spring.
43. Lower Band Swivel.
44. Lower Band Swivel Screw.
45. Floor Plate.
46. Floor Plate Catch.
47. Floor Plate Catch Pin.
48. Floor Plate Catch Spring.
49. Guard.
50. Magazine Spring.
51. Main Spring.
52. Base.
54. Base Pin.
55. Base Spring.
56. Eye Piece.
57. Eye Piece Knob.
58. Eye Piece Knob Pin.
59. Eye Piece Screw.
60. Joint Pin.
61. Leaf.
62. Slide.
63. Slide Pin.
64. Slide Screw.
65. Slide Spring.
66. Slide Spring Plunger.
67. Slide Shoe.
68. Receiver.
69. Rod Bayonet.
70. Rod Bayonet Catch.
71. Rod Bayonet Catch Spring.
72. Rod Bayonet Stud.
73. Safety Lock Spindle.
74. Safety Lock Thumb Piece.
75. Sear.
76. Sear Joint Pin.
77. Sear Spring.
78. Sleeve.
79. Sleeve Lock.
80. Sleeve Lock Pin.
81. Sleeve Lock Spring.
82. Stacking Swivel.
83. Stacking Swivel Screw.
84. Stock.
85. Striker.
86. Trigger.
87. Trigger Pin.
88. Upper Band.
89. Thong.
90. Thong Case and Oiler.

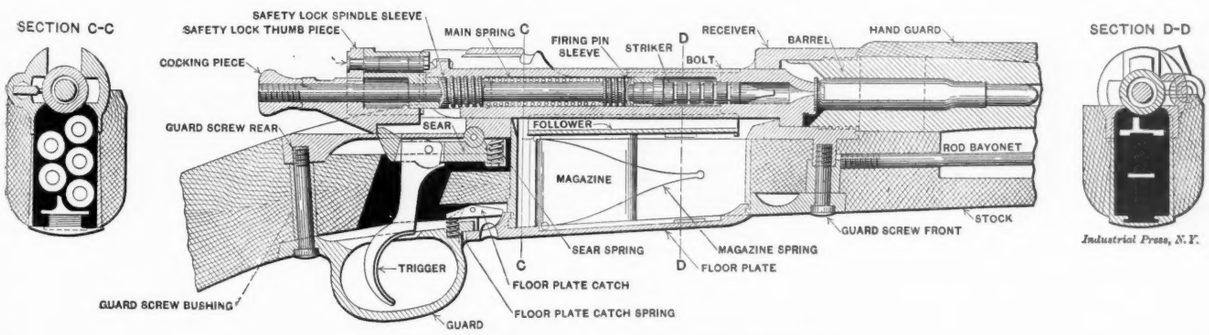


Fig. 3. Sectional View, showing Details of Breech Mechanism.

take the position shown in the cross section view at the left of Fig. 3. The clip is discarded when the filling of the magazine is completed, the forward movement of the bolt throwing it to the ground. The gun can be used as a single-loader by cutting off the magazine.

The construction is simple and strong. Two lugs are provided on the bolt, instead of one, to resist the breech pressure. The location of the magazine does not impair the balance of the arm, and, being entirely concealed, it does not detract from the appearance. In fact the lines of the new gun are nearly as pleasing to the eye as those of some sporting rifles. The barrel is only 24 inches long and is entirely incased in a wood sheath, the object of which is to prevent the heating of the barrel, due to rapid firing, interfering with the handling of the piece. The uniform protection of the barrel also prevents unequal radiation and consequent deflection of the barrel which would result in inaccurate shooting. The barrels are turned so as to make the exterior perfectly concentric with the bore, and the seating of the barrel in frame is a detail that has been carefully worked out. Further description need not be given here, but suffice it to state that the details of design and manufacture have been planned with the view, so far as possible, of obtaining the maximum accuracy and efficiency in one type of weapon that shall be adapted to all branches of military and naval service. The new gun is to be manufactured at the government arsenals at Springfield, Mass., and at Rock Island, Ill., for the present at the rate of about 350 per day.

* * *

A STUDY OF ALLOYS SUITABLE FOR BEARING PURPOSES.

In an elaborate article, in the *Journal of the Franklin Institute* for July, Mr. G. H. Clamer discusses the advantages and disadvantages of various compositions and alloys for bearings, and especially alloys for railway journal brasses. He also quotes the results of many tests on various compositions made on an Olsen testing machine designed by Prof. Carpenter of Cornell University.

Upon close examination we find that there are but few metals available for bearings. They are copper, tin, lead, zinc and antimony. While other metals may be introduced in greater or less proportions, the five mentioned must constitute the basis for the so-called anti-friction alloys. The combinations of these metals now used may be grouped under the two heads of white metal and bronze. Bronze is the term which was originally applied to alloys of copper and tin as distinguished from alloys of copper and zinc; but gradually the term "bronze" has become applied to nearly all copper alloys containing not only tin, but lead, zinc, etc., and no sharp lines of demarcation exist between the two.

White metals are made up of various combinations of lead, antimony, tin, copper and zinc, and may contain as few as two elements, or all five. Bronzes are made up of combinations of copper, tin, lead and zinc, all of them containing copper and one or more of the other elements. The essential characteristics to be considered in any alloy for bearings are composition, structure, friction, temperature of running, wear on bearing, wear on journal, compressive strength, and cost.

It is utterly impossible to have one alloy reach the pinnacle of perfection in all the above requirements, and so it is important to study the possible compositions and determine for what purpose each is adapted. It has been shown that a bearing should be made up of at least two structural elements, one hard constituent to support the load and one soft constituent to act as a plastic support for the harder grains. Generally speaking, the harder the surfaces in contact the lower the coefficient of friction and the higher the pressure under which "gripment" takes place. It would seem for this reason that the harder the alloy the better; and it was with this idea in mind that the alloys of copper and tin were so extensively used in the early days of railroading. A hard, unyielding alloy for successful operation must, however, be in perfect adjustment, a state of affairs unattainable in the operation of rolling stock. For this reason the lead-lined bearing was introduced and the practice of lining bearings has now become almost universal in this country.

While the harder the metals in contact the less the friction, there will also be the greater liability of heating, because of the lack of plasticity, or ability to mold itself to conform to the shape of the journal. A hard, unyielding metal will cause the concentration of the load upon a few high spots and so cause an abnormal pressure per square inch on such areas, and produce rapid abrasion and heating.

The bronzes will, generally speaking, operate with less heat than softer compositions, while the softer metals will wear longer than the harder metals. In the matter of wear of journal, however, the soft metals are more destructive. Particles of grit and steel seem to become imbedded in the softer metal, causing it to act upon the harder metal of the journal like a lap. High-priced compositions are being used that have but little resistance to wear compared with cheaper compositions, and low-priced alloys are in service that are not cheap at any price. It is generally conceded that soft metal bearings cause a marked decrease in the life of the journal, and yet they have many marked advantages, as we shall presently see.

Bearings Containing Antimony.

Lead and antimony: These metals will alloy in any proportion. With increase in antimony the alloy becomes harder and more brittle. It has been determined that when this is made of 13 parts antimony and 87 parts lead the composition will be of homogeneous structure. If there is a greater proportion of antimony, free crystals of antimony appear, imbedded in the composition; and if less than 13 per cent. there appear to be grains of the mixture itself imbedded in the lead as the body substance.

According to one writer an anti-frictional alloy should consist of hard grains, to carry the load, which are imbedded in a matrix of plastic material, to enable it to mold itself to the journal without undue heating. Such a condition would be met in a lead and antimony alloy having above 13 per cent. antimony; but it is not advisable to use in any case more than 25 per cent. antimony, as the composition would be too brittle. The same writer claims that alloys having from 15 to 25 per cent. antimony are the best adapted for bearings. The author of the paper under review, however, does not agree with this, and says that alloys containing below 13 per cent. antimony can likewise be said to consist of hard grains consisting of the composition itself, imbedded in the softer material, lead, as mentioned above. He says: It has been my experience that, although the friction may be higher in such alloys, the wear is greatly diminished, and where pressures are light, causing no deformation, this is a great advantage. I have seen many instances in service where alloys between 15 per cent. and 25 per cent. were greatly inferior to alloys between 8 per cent. and 12 per cent., owing to their frequent renewal due to wear. It will perhaps be interesting to hear that the Pennsylvania Railroad Company, at the suggestion of Dr. Dudley, their chemist, have adopted the 13 per cent. antimonial lead alloy as a filling metal for bearings in order to obtain the best results.

In a general way my own work in the subject has confirmed the opinion that lead is the best wear-resisting metal known, and that with increasing antimony, or increasing hardness and brittleness, the wear becomes more marked. This is due to the splitting up of the harder particles.

The friction, as we may naturally expect, becomes less with increase of antimony, and the temperature of running likewise diminished when running under normal conditions; but the harder the alloy, the more difficulty is experienced in bringing it primarily to a perfect bearing, and the greater the liability of heating through aggravated conditions. The wear on the journal one would naturally expect to be decreased with increasing hardness; but this journal wear is in all probability not due so much to the alloy directly as it is to the fact that the softer metals collect grit, principally from the small particles of steel from the worn journal, and, acting as a lap, cause rapid wear. With the harder metals these particles are worked out without becoming imbedded.

The cost of the lead and antimony alloy is the least which can be produced. It can be used in many services where higher-priced alloys are being relied upon mainly for their

high cost. It is one of the greatest extravagances of large industrial establishments to use materials that are too good for certain uses, and even perhaps unsuited, under the supposition that they must be good because they paid a good price for them. This fact has no greater exemplification than in the purchase of babbitt metal, and is due to the great uncertainty which exists, not only among consumers, but among manufacturers, many of whom carry on their business much the same as the patent-medicine man.

Lead, Antimony and Tin: I do not wish it understood that antimony-lead is the cheapest alloy to use under all circumstances; not so, for when high pressures are to be encountered, tin is a very desirable adjunct. Tin imparts to the lead-antimony alloy rigidity and hardness without increasing brittleness, and can produce alloys of sufficient compressive strength for nearly all uses. The structure of a triple alloy of this nature is quite complicated, and not yet definitely defined.

The cost of the alloy increases with increase of tin; but for certain uses, where sufficient compressive strength cannot be gotten by antimony, because of its accompanying brittleness, it is indispensable, and will answer in nearly every case where the tin basis babbitts are used.

Tin and Antimony: These are seldom used alone as bearing alloys, but are extensively used for so-called Brittania ware, and in equal proportions for valve seats, etc.

Tin, Antimony and Copper: This combination is what is known as genuine babbitt, after its inventor, Isaac Babbitt, who presumably was the first man to conceive the idea of lining bearings with fusible metal. The formula, which for no arbitrary reason he recommended, is as follows:

Tin	89.1
Antimony	7.4
Copper	3.7

This formula is still considered the standard of excellence in the trade, and has been adopted by many of the leading railroads, the United States Government and many industrial establishments. It is used in the majority of cases where cheaper composition would do equally as well. It is the most costly of all bearing alloys because of the high content of tin.

Tin-Antimony-Lead-Copper: This quadruple combination of metals I will not venture to describe, as it would no doubt take years of study to fathom the complicity of the metallic combinations here represented. Suffice it to say that lead, although of itself a soft metal, renders this alloy, when added in but small proportions, harder, stiffer, more easily melted and superior in every way to the alloy without it, and yet consumers will raise their hands in horror when a trifling percentage of lead is found in their genuine babbitt. This is one of the instances where cheapening of the product is beneficial.

The foregoing represents the more important combinations of alloys of tin and lead basis. These are of far more importance in the arts than the white metals, the main portion or basis of which is zinc.

At various times new combinations of zinc have been proposed, but so far as my knowledge goes, they have not come into popular use for two reasons: First, because of the great tendency of zinc to adhere to iron when even slightly heated. What is technically known as galvanizing the journal is effected under these conditions. Second, because of the brittleness produced under the effects of heat, such as is produced by friction when lubrication is interfered with, and consequent danger of breakage.

Bronzes.

Bronze is the term which originally was applied to alloys of copper and tin as distinguished from alloys of copper and zinc.

Copper and Tin: This, according to our general conception of the word, is a bronze only when the copper content exceeds that of the tin. According to the proportions in which the metals exist, it has widely different properties. In general, the tin hardens when present up to proportions of 30 per cent., or perhaps a little over, and when this limit is exceeded, it takes on more and more the nature of tin until pure tin is reached. From a scientific point of view this alloy is one of the most interesting and has attracted the attention of many investigators, who have spent years of study on it, to learn its various properties and explain its constitution.

The alloys which interest us most, however, are those which are so constituted as to be adapted for bearing purposes. These would be said to contain from 3 to 15 per cent. tin, and from 85 to 97 per cent. copper. The alloy of tin containing smaller percentage of copper is often used as a babbitt metal, but this comes under the class of white metals, which I have already discussed. Bronze containing above 15 per cent. of tin has been recommended at various times for bearings owing to its hardness, but very unwisely, for such a bearing assumes mechanical perfection and perfect lubrication. It has no plasticity of its own, and as soon as the oil film is interrupted rapid abrasion and gripment take place, with hot boxes as the result. The very erroneous idea is still held by many, that to resist wear and run with the least possible friction a bearing alloy must be as hard as possible. It is true that hard bodies in contact move with less friction than soft ones; but the alloy which is the least liable to heat and cause trouble is the one which will stand the greatest amount of ill use; by this I mean an alloy which has sufficient plasticity to adapt itself to the irregularities of service without undue wear. The enthusiasts over hard bearings have even gone so far as to try glass for this purpose, and whereas this substance may give satisfaction on perfectly adjusted light spindles, for example the jewel bearings of a watch, we can readily imagine what would be the consequence if such a trial was made on locomotive or car journal bearings. It is for the foregoing reasons that I have limited the useful bearing alloys of copper and tin to those containing less than 15 per cent. tin, and began my investigation from this point.

The alloys of copper and tin were used extensively some twenty or twenty-five years ago, and were considered the standard for railroad and machinery bearings. The old alloy, known as "Cannon Bronze," containing 7 parts copper and 1 part tin, is still being specified by some few unprogressive railroad men and machinery builders.

COPPER AND TIN, AND COPPER, TIN AND LEAD SERIES.

	Copper.	Tin.	Lead.	Friction.	Temp. above Room.	Wear in Grams.
1	85.76	14.90	.....	13	50	.2800
2	90.67	9.45	.....	13	51	.1768
3	95.01	4.95	.....	16	52	.0776
4	90.82	4.62	4.82	14	53	.0542
5	85.12	4.64	10.64	18½	56	.0380
6	81.27	5.17	14.14	18½	58	.0327
7	75?	5?	20?	18½	58	.0277
8	68.71	5.24	26.67	18	58	.0204
9	64.34	4.70	31.22	18	44	.0130

Copper, Tin and Lead: This composition is now recognized the standard bearing bronze, its advantage over the bi-compound coming from the introduction of lead. The bronze containing lead is less liable to heat under the same state of lubrication, etc., and the rate of wear is much diminished. For these reasons and the additional fact that lead is cheaper than tin, it seems desirable to produce a bearing metal with as much lead and as little tin as possible. The metal known as Ex. B. composition tin 7 per cent., lead 15 per cent., copper 78 per cent., is stated by Dr. Dudley to be the best that can be devised, this being the smallest quantity of tin that will hold the lead alloyed with the copper. By adding a small per cent. of nickel, however, to the extent of one-half to 1 per cent., a larger proportion of lead may be used, and successful bronzes have been made which contained as much as 30 per cent. lead by this process. Such bronzes, containing a large amount of lead, through the addition of nickel, are known in the trade as "Plastic Bronzes" and are a regular commercial article. The table above gives the results of tests on different compositions of bronzes.

* * *

One of the interesting and valuable features of the steam turbine is that there appears to be practically no limit to the size which single units may be built. In fact the larger the wheel the better, since the peripheral speed of both large and small wheels should be about equal, and given the larger wheel, the less, of course, the number of revolutions per minute.

LOUISIANA PURCHASE EXPOSITION.

PRELIMINARY PLANS—THE ENGINEERING FEATURES.

Work has so far progressed upon the buildings and grounds of the Louisiana Purchase Exposition, and the plans have been so far developed, that it is now possible to give definite information upon many of the features of the exposition, with reasonable assurance that they will be carried out as outlined. We present a reproduction of a photograph of Machinery Hall, taken August 10, showing the state of completion, and also an engraving of the latest ground plan of the exposition. Nothing is shown on this plan save items which are either completed or in process of completion or definitely contracted for. As a matter of fact there are a great many features not shown on this plan, which, however, are practically decided on and which will completely fill the apparently unoccupied spaces of the map. For example, the entire section called "The Pike," lying to the north of the Varied Industries and Transportation Buildings, and the sections lying between the Transportation and the English section; and between the Machinery and the French sections and thence southerly to the east of Skinker Road, is devoted to concessions and constitutes the "Midway." Since July 15th practically all of this space has been allotted to concessionaires. To give a clearer and more immediate idea of the general character of the Exposition plan, special prominence is given on the map to the Intramural Railway; and the waterways, the Machinery Building and the Steam, Gas and Fuels Building, called on the ground plan the "Boiler House," are made more conspicuous by cross-sectioning.

Fig. 1. Machinery Building, now nearly Completed.

With reference to the Intramural Railway, this consists of a double-track trolley road, standard gage and standard type of open cars. The motor equipment and control is furnished by the General Electric Company; the brake equipment and control is furnished as an exhibit by the National Electric Company; the power plant for the operation of the road will be located in the central portion of Machinery Hall and the prime movers in this plant are as follows:

1. A 1,500 H. P. Oechelhauser system gas engine (100 R. P. M.) built and exhibited by A. Borsig, Tegel-Berlin, and supplied with gas from a producer plant built and exhibited by Julius Pintsch, Berlin.

2. A 900 H. P. Corliss type steam engine (85 R. P. M.) built and exhibited by the Murray Iron Works Company, Burlington, Iowa.

3. A 750 H. P. modified Corliss steam engine (100 R. P. M.) built and exhibited by the Lane & Bodley Company, Cincinnati, Ohio.

4. A 600 H. P. four-valve steam engine (150 R. P. M.) built and exhibited by the Harrisburg Foundry and Machine Works, Harrisburg, Pa.

The Crocker-Wheeler Company, Ampere, N. J., build the generators, which in every instance are directly coupled to the prime movers and deliver current at 550 volts at the switchboard.

In addition to the foregoing there will probably be included in this Intramural Power Plant a combination which, while not economical in efficiency, will have features interesting to the engineer and attractive to the public. This combination consists of a steam pump built and exhibited by the Jeanesville Iron Works Company, Jeanesville, Pa., which is planned to deliver 1,200 gallons of water per minute at a pressure of 300 pounds, the water being conveyed through a pipe line and delivered against a tangential water wheel built and exhibited by the Abner Doble Company, San Francisco, Cal. This water wheel will be encased in plate glass. It will run at 900 R. P. M., and it is to be directly coupled to a Crocker-Wheeler generator. Incidental features will be a Lombard governor on the water wheel and a Venturi meter measuring the water delivered through the pipe line. The Intramural Power Plant will have its own independent system of boilers, stokers, force draft apparatus, piping, condensers, pumps, etc.

With particular reference to the water ways, the main one consists of a grand basin with lateral lagoons. The water is delivered into this basin from a niche in front of Festival Hall and from fountains in front of two ornate restaurant buildings which flank the Terrace of States. From these three

points it flows over cascades and it is to be illuminated by electric lights placed under the lip of each step, which breaks the spill. The water is to be lifted by three centrifugal pumps built and exhibited by the Henry R. Worthington Company. Each pump is planned to deliver 30,000 gallons of water per minute against a total head of 158 feet. Three induction-type motors, each of 2,000 H. P. rating, are to operate the pumps. The magnitude of this feature will be better appreciated by the statement that the total water moved in the Paris Exposition of 1900 was about 4,500 gallons per minute and at the Buffalo Exposition of 1901 about 7,000 gallons per minute, while here in this cascade feature alone we are to move 90,000 gallons per minute. The energy required for the operation of this feature equals the total energy had from the Niagara power plant by the Pan-American Exposition and the total energy used for illuminating the latter exposition. The secondary water system consists of Arrow Head Lake. This lake is to afford an opportunity to illustrate the water dwellings and water life of the Philippines. There is a proposition on foot to afford Messrs. Farcot Freres & Company, St. Ouen-sur-Seine, France, an opportunity to install in the center of this lake a fountain which they claim will project a free jet of water to a height of about 250 feet. As the normal level of the water in Arrow Head Lake is about 40 feet higher than the water level in the grand basin, this jet would have an extreme elevation as above the surrounding country of approximately 300 feet, and when illuminated it should be visible within a radius of from ten to twenty-five miles. Messrs. Farcot Freres & Company furnished the pumps for the water display in the Paris Exposition of 1900. The particular pump which they suggest for this jet is to be driven by electric motor and it is claimed will not require more than 250 H. P. for its operation.

With particular reference to Machinery Hall and the Steam, Gas and Fuels Building, it is very gratifying to note that they will be found near the center of the grounds. The Steam, Gas and Fuels Building is a steel structure covering an area of about 100,000 square feet, and is well adapted for the installation of the class of exhibits which it is to contain. The topics to be covered by exhibits in this building are the storage, handling, preparation and conveying of fuels; the conversion of natural fuels into briquettes; the production of gas for power uses; the purification of water for boiler use; the generation of steam in boilers of both the stationary and marine types; mechanical stoking; force draft, and any subjects relating to steam generation, control and transmission. The management have done well in giving the exhibits so prominent a position, as in all former expositions the boiler house has been a boiler house pure and simple and always tucked away somewhere in the background and removed from a point where the exhibits attracted the attention of the public.

Machinery Hall is practically finished and is said to be the best exhibit building ever constructed. It has good light and air; freedom of vision and long vistas; a floor immediately on the ground level and a foundation soil naturally good. Prime movers and their accessories will occupy the westerly half of Machinery Hall. There will be found there a total of

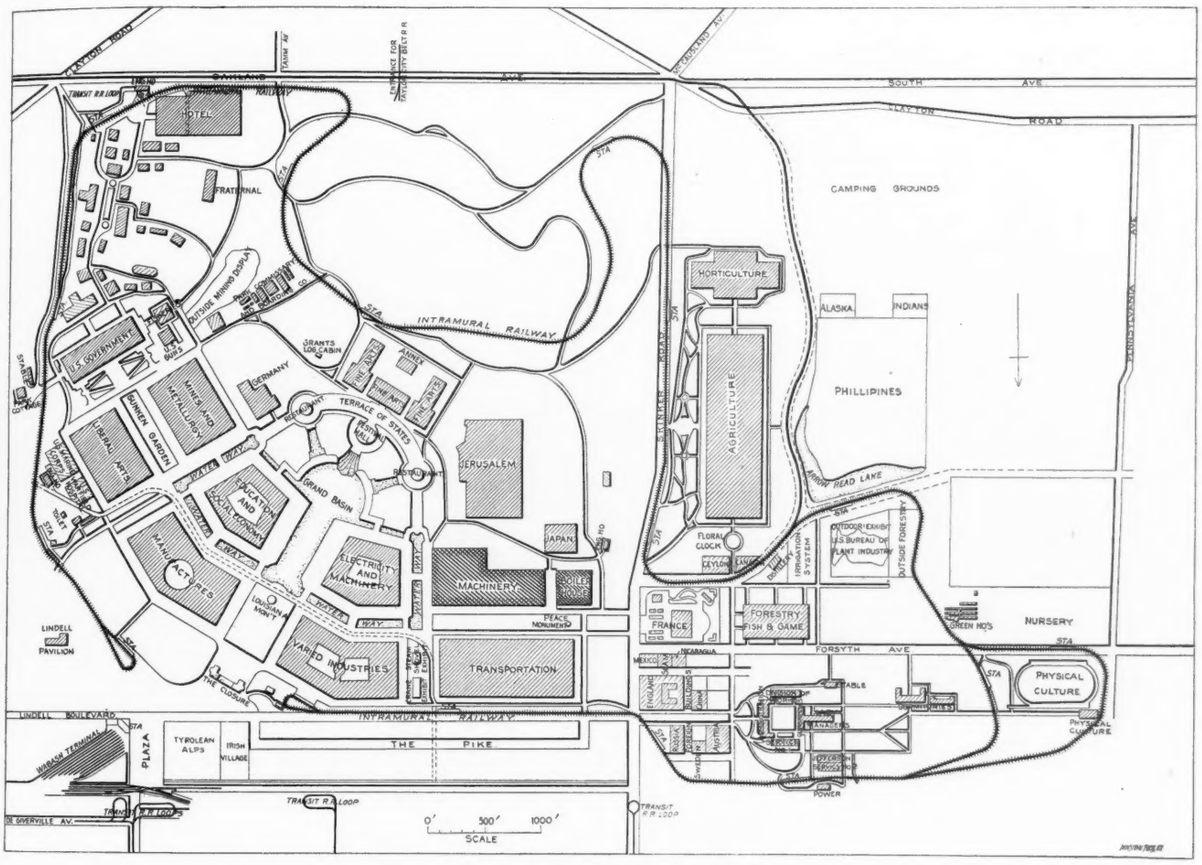


Fig. 2. Plan of Exposition Grounds as now Laid Out.

Among the most notable units will be the following: An 8,000 H. P. and a 5,000 H. P. steam turbines; a 5,000 H. P. Allis-Chalmers Manhattan type reciprocating steam engine; a 3,500 H. P. Belgian, a 1,750 H. P. and 900 H. P. German, and an 1,800 H. P. American gas engines; a 1,500 H. P. vertical French steam engine giving 330 R. P. M. and working in parallel on arc lighting service with a German tandem compound steam engine of 1,000 H. P. and 94 R. P. M. The full range and ratings will be illustrated in each of the three great groups of prime movers—reciprocating steam engines, steam turbines, and explosion engines. In practically every instance, generators will be directly coupled to the engines. About 80 per cent. of the energy developed will be in 6,600 A. C., three-phase, 25-cycles; this for the general lighting and hydraulic work of the Exposition, but there will also be current of 2,300 volts, 50 cycles, three phase A. C., generated by foreign exhibits and used for the arc lighting, and there will be the 550-volt D. C.—as before referred to—for the

operation of the intramural road. There will also be minor installations for the generation of both A. C. and D. C. of standard voltages for the motor service of exhibitors in Machinery Hall.

To the east of the engine installation will be an air compressor plant which will furnish the air for the operation of pneumatic machinery and for the locomotives in the Transportation Building. Immediately in this vicinity the pump exhibits will be found and machine tools will occupy the northeast quarter of the building and woodworking machinery and fire engines and apparatus the southeast quarter of the building.

* * *

MACHINE SHOP ROOFS,*

WITH DESCRIPTION OF A SPECIAL STEEL-CONCRETE CONSTRUCTION.

One of the largest foundries and machine shops to be destroyed by fire in recent years was that of the Brown Hoisting Machinery Company, Cleveland, O., whose plant burned in December, 1900, but has since been rebuilt on a larger scale and is of more durable construction.

The walls of the main building were of brick, supporting the outer ends of steel trusses, of which the inner ends were supported by unprotected steel columns. The floors of the building were of 2-inch plank, nailed to 4 x 4 stringers, set in 18 inches of cinders. The roof was of plank covered with slate. A corrugated iron covered gasoline tank was in the end of the building and it was in this that the fire started through the carelessness of a workman. Once under way, it spread with such rapidity as to travel the length of this building, and out around a "U"-shaped building to the street in less than seven minutes. As a result the whole plant was destroyed, with the exception of the office building and a small pattern vault, which were accessible on all sides by a 16-foot driveway.

In erecting the new plant, the office building was moved across the street and out onto a vacant lot, where wings were built on each side. The area covered by the "U"-shaped building referred to, and most of the other buildings of the old plant, is now occupied by a single structure 500 x 312 feet. In addition to this a pattern shop and pattern vaults have been erected and a power house, service building, and warehouse are in process of design and construction.

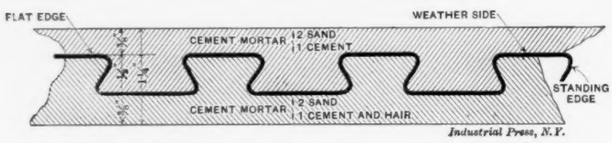


Fig. 1. Section of Ferroinclave Steel-concrete Roof.

One reason for the rapid spread of fire in the old plant was the wooden roof construction. It was determined that in the new shops this fault should be corrected and an extended investigation of various forms of roof construction was begun, Mr. Alexander Brown, vice-president of the Brown Hoisting Machinery Company, giving the matter his personal attention. In the new works it was considered necessary that cranes should be high enough above the floor to place heavy parts on the top of machines which were 40 or 50 feet high, and before designing the trusses it was necessary to decide on a fireproof roof which should be light and inexpensive. Slate laid on light steel supports would condense moisture badly; ordinary corrugated iron was objectionable for the same reason; roofing tile entailed a large number of purlins, which made the expense of the structural work very high, and also they were not at all suited to the saw-tooth roof construction. This brought the matter down to a concrete roof. The majority of those upon the market had to be made from 2 inches to 3 inches thick to obtain sufficient strength to span 5 feet. To keep the weight down, some concerns recommended the use of cinder concrete with a steel reinforcement. This could not be expected to be permanent on account of the action of the cinders in rusting away the reinforcing metal. In addition to these points, the concrete roofs were very expensive, especially when the cost of the excessive amount of structural work for supporting the roof was added to the cost of the roof itself.

These considerations finally led to the design of a steel-concrete roof which is used on all the new buildings and has now been placed on the market under the name of "Ferroinclave" roofing. A section of the roofing is shown in Fig. 1 and the half-tone illustrations indicate its appearance when completed and under construction and illustrate the method of

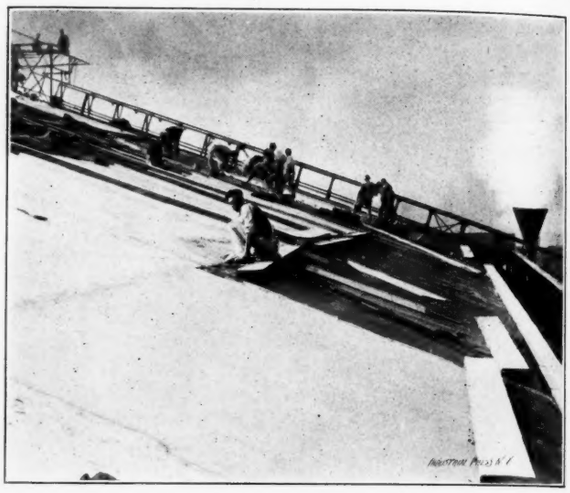


Fig. 2. Applying Cement to the Corrugated Steel Sheets.

applying it. It was determined that a cement roof 1¼ inch thick would be sufficient to prevent undue condensation and it remained but to devise a reinforcing material that would have sufficient strength to support a snow load of 30 pounds per square foot. The reinforcing sheet adopted is of corrugated sheet steel, made 10 feet long, 20 inches wide, and ½ inch thick, of No. 24 metal. The corrugations run the long way of the metal and are in the form of a dovetail. As they are wider at one end than at the other, one sheet will shingle edgeways into another sheet.

The sheets are laid upon the tops of the purlins, spaced 4 feet 10½ inches, and clipped to them in very much the same manner as an ordinary corrugated iron roof is laid. The metal is stiff enough to support the weight of the laborers, who then spread upon the upper side a mixture of two parts of sand and one part of Portland cement. The under side of the roof is coated with a similar mixture, which contains also a small amount of lime and hair. This is put on the under side in the same way that plaster is put on to the ceiling of a room. When the cement has set for about ten days, the upper side is coated with two coats of a special non-drying paint, which renders the roof perfectly water-tight.

In the circular from which we have taken most of the facts appearing in this article, Mr. Edward Atkinson, the director of the Insurance Engineering Experiment Station, says that for years a suitable outside covering for roofs has been sought, adapted for flat roofs, or roofs of half-inch pitch, that should be as durable and safe as the composition roof of tar and gravel and, if possible, lighter in weight. Outside the practice in slow-burning construction, omitting the costly fireproof buildings with roofs of brick, concrete and steel, the roofs of miscellaneous buildings are usually the most unfit and dangerous parts of buildings in respect to the spread of fire. The great Boston fire spread by way of the roofs. The worst type of roof is the pitched roof of boards, laid on joists 18 inches to 2 feet on centers, covered with slate; worse when sheathed and ceiled inside than when not so finished within. The roof of flat section, of boards laid on joists, sheathed underneath, is bad and dangerous. For isolated buildings in the country the roof of boards, shingled outside, is somewhat unsafe and liable to be set on fire by sparks, while it transmits heat readily. On the other hand a roof of

*For most of this article we are indebted to a recent report of the Insurance Engineering Experiment Station, Boston. While the description relates mainly to one type of roof, the facts presented comprise a valuable supplement to the articles on shop construction that have appeared in our columns.

matched boards with shingles laid over half inch of lime mortar, is safe, non-conducting, and very durable.

Prof. Charles L. Norton, of the Massachusetts Institute of Technology, has submitted samples of Ferroinclave roofing to test and reports as follows:

Under the action of fire against the lower side, the roofing became gradually heated through until at the end of an hour bits of wood were charred upon being placed in contact with the top of the roof. The temperature of the fire was from 1,700 deg. F. to 1,900 deg. F. A few cracks developed on both sides of the slab in less than ten minutes, but none of them penetrated further than to the steel sheet, and no fire came through the slab during the four hours' test.

At the end of two hours the temperature of the top of the roof had risen to the igniting point of wood, but at the end of four hours it had not risen sensibly higher. Upon cooling with a stream of water the roof was found practically intact, except for a softening of the lower surface, and the development of a few fine cracks in each surface—none penetrating more than half way through. The condition of the roof was such that it was still at the close of the test a good fire stop and with a little cement plastering it would have been, in appearance and efficiency, in its original condition.

A second test was made to determine the conductivity of the roof and its liability to cause condensation. Its thermal conductivity or heat-carrying power is nearly six to eight times that of a 2-inch spruce plank, and the condensation or drip on the lower side would be much greater. It is impossible to make an accurate estimate of the amount of this condensation. The experience of a whole winter is needed to settle the matter definitely. I see no reason to question the permanency of the roofing. There is no danger of the steel web being corroded if the cement is properly applied.

To sum up: The roofing is a fire retardant of a high order; is itself incombustible; more liable than wood to cause a drip; durable, strong and light.

In the matter of cost, comparative figures are given for a Ferroinclave roof, a foundry or machine shop roof of ordinary construction, and the cost of an ordinary roof equipped with a sprinkler system for its better fire protection. The items for the Ferroinclave roof are as follows, for a square of 100 square feet, the cost of cementing presumably being at the labor rates prevailing in Cleveland:

	Per Square.
Ferroinclave sheets	$8.50
Fastening clips	.48
Laying Ferroinclave	1.25
Cementing upper side	3.00
Cementing under side	4.00
Water-proofing coating	1.50
Sundries, freight, superintendence, etc.	1.27
Total	$21.00

The items for a roof of common construction are as follows:

	Per Square.
Plank, including nailing strip on purlins	$6.90
Laying	3.00
Painting on under side of plank (two coats)	1.75
Tar and gravel roof	4.50
Apportionment for repairs for tar and gravel roof, on the assumption that the life of this roof is ten years	.45
Total	$16.60

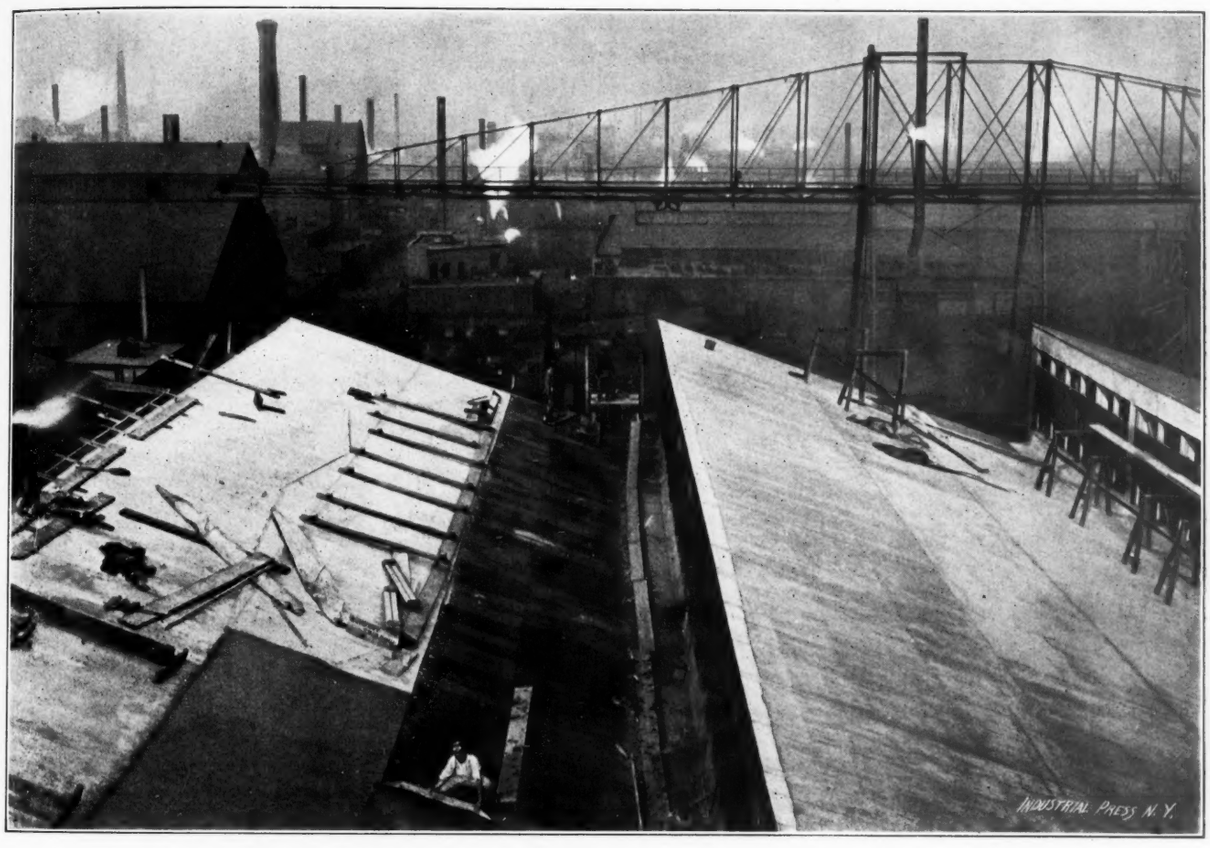


Fig. 3. Part of Roofs of New Shops of the Brown Hoisting Machinery Company, Cleveland—Steel-concrete Construction.

The plank roof coated with tar and gravel will weigh about 10 pounds per square foot. The Ferroinclave roof is about 1¼ inch thick and weighs 15 pounds to the square foot. A snow load for each of 30 pounds per square foot must be provided for, so that the purlins and trusses must be designed to support 40 pounds per square foot of roof in one case and 45 pounds in the other—substantially the same weight. To equip a plank roof with sprinklers is estimated to cost $35 a square, including underground connections, gravity tank, valves, etc., assuming the roof to cover a total area of 124 squares. The cost alone of sprinklers and pipe connections for same would be nearly $7 per square.

* * *

The addition of nickel to steel gives a two-fold advantage: First, it increases the strength and ductility of a steel of given carbon content; and second, permits the use of a higher carbon and therefore stronger steel, because it gives the high carbon steel greater endurance under shock. The characteristics of nickel steel are toughness, great tensile strength, high elastic limit, and the ability to withstand shock.

MACHINE SHOP EQUIPMENT.—2.

THE EQUIPMENT OF THE TOOL ROOM AND STORE ROOM

OSCAR E. PERRIGO.

Before proceeding with the regular text of this article the writer desires in this formal and public manner to heartily thank the many manufacturers who have very kindly sent valuable catalogues, circulars and other printed matter, and even blueprints of their products, as well as letters of approval and good wishes for the success of this series of articles. These favors show emphatically the broad-mindedness of the busy manufacturers and a commendable desire to assist in any effort to spread useful information in reference to mechanical subjects.

Fig. 1

In the previous article we considered in detail the machine tool equipment necessary in the various departments of the machine shop, and the location of the machines in each group or department, all arranged for convenient supervision and for the ready handling of the stock and the finished parts.

In that article the *machines* in which the work was to be done were considered. In this article it is proposed to consider the *tools* for use in these machines, including a department for making them and proper arrangements for their care, such as providing a place for their safe keeping and regular issue to the shop. It is also proposed to consider, in connection with the store room for tools, the arrangement of the store rooms for the smaller kinds of rough stock, and such purchased parts as are received complete from outside dealers or manufacturers. This plan leads us into the office portion of the building, and consequently a brief explanation of this part of the establishment does not seem out of place, inasmuch as it is, in a purely manufacturing plant, so intimately connected with all the machine shop operations, rather than partaking of the commercial side of the marketing of the product.

The large cut, Fig. 3, accompanying this article, is a plan of the front portion of the machine shop building, showing the relative location of the offices, tool making department, store rooms, etc., and the essential parts of their internal arrangements.

The main entrance to the office part of the buildings is through wide double doors from a large porch and opening into a public space in the portion devoted to office arrangements. The divisions of this portion of the building are clearly shown in the drawings. Upon the outer side are located the superintendent's public and private offices, between which is the stairway leading to the drawing room above, and the necessary toilet conveniences. The public space is separated from the large central space of the general office by a railing, doors opening from both these into the superintendent's public office. The bookkeepers' desks are so arranged that a cashier's window opens into the public space. The timekeeper's desk is surrounded by wire netting, secluding his work from the general work of the office. A door leads into the gateway space, across the large platform scales and into the tool room portion of the building opposite. At one side of this door and as far away from the general work as may be is the telephone booth. A wide hall leads from the central space to the machine shop proper, and divides the private office from the purchased parts store room. This latter is so placed because the purchase, receipt and issue of such stock is more intimately connected with the office work than that of the rooms in the opposite side of the building.

The tool making department is purposely placed away from the general machine shop, as a too intimate connection with it does not seem desirable in practice, while it should be convenient to the drawing room and the pattern shop, which may be reached by the stairs next to the rough stock room, as shown. It occupies the entire front of this square, front structure and is provided with a variety of machines rendered necessary for the making of modern tools and fixtures for properly machining small or medium sized parts. The character of each of these machines is indicated on the drawing. It is also provided with the grinding machines for grinding such tools as lathe tools, planer tools, twist drills, etc. It will be noticed that in providing the machine tools for making jigs and fixtures particular attention is paid to grinding facilities since these are in many cases the best adapted to such accurate work, both as to producing good work and to doing it economically. Large pieces of heavy fixtures may, of course, have to be planed in the planing department, but these cases will seldom occur. The tempering of tools will best be done in the forge shop, the tools being sent there in quantities when possible, rather than to attempt such work in the tool making room with hand forges.

A foreman's office is provided so that he may have a proper place for keeping the records of the work of the department as well as a private room for convenience in making such sketches, plain drawings or details as he may find necessary in carrying out the plans for tool making; these are not always worked out in sufficient detail by the drawing room force, or such as he may wish to devise himself for special work and develop as the necessities for them may arise.

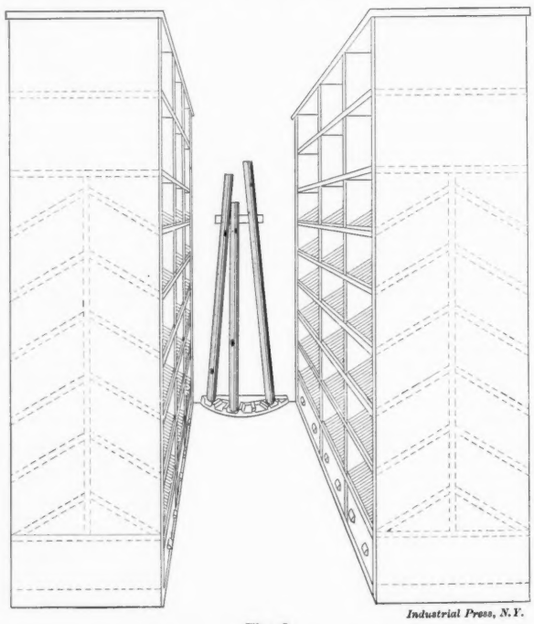


Fig. 2.

To avoid confusion in the tool making department, a tool store room is provided, where the usual supply of lathe and planer tools, twist drills, taps, reamers, arbors, etc., is kept and issued to the tool-distributing points such as the general room near the engine room and the foremen's offices. In this room are also kept, when they are not in use, the jigs and fixtures necessary for machining small parts, as they can be better cared for here than in the machine shop. The en-

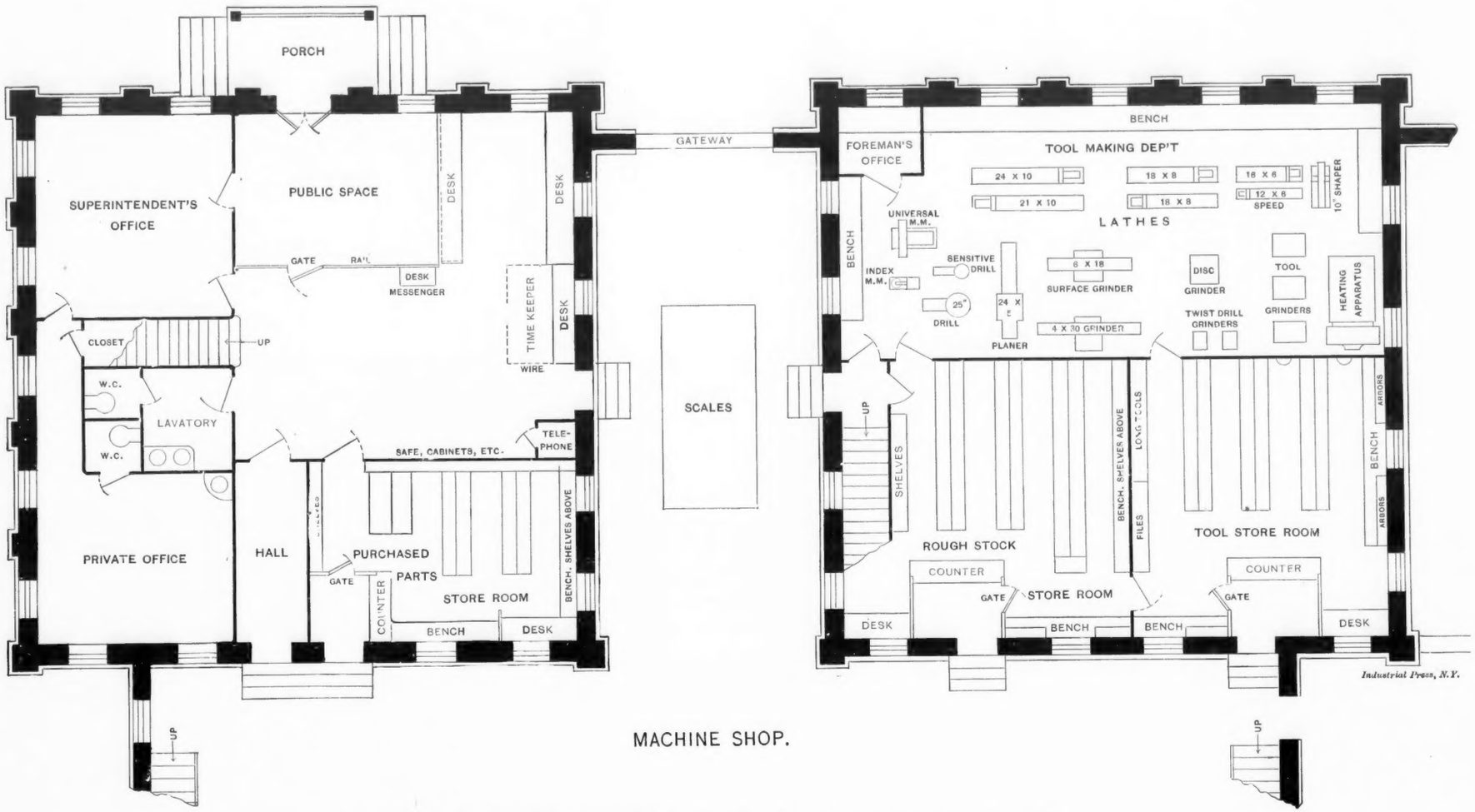


Fig. 3. Plan View of Shop Offices, Tool Room and Store Room, all of which adjoin the Machine Shop.

trance to this room for the workmen is so arranged that he enters a space in front of a counter and has no access to the main space of the room. This will prevent confusion and enable the tool keeper to do his work quickly and properly. To save unnecessary distance in reaching all tools and fixtures the alcoves of shelves are so placed that the alleys all terminate near the issuing counter. At the right is a convenient bench arranged with arbor racks as shown in Fig. 1. These racks will accommodate arbors from four to seven feet in length. The same form of racks may be arranged for any length too long for conveniently placing on the shelves. Beneath this bench are strong shelves upon which may be placed heavy jigs and fixtures. Fig. 2 shows cases of inclined shelves arranged with strips for holding such tools as drills, reamers, short arbors and similar tools, and at the far end another form of arbor rack. This may, if preferred, be arranged similar to the arbor rack shown in Fig. 1. The series of inclined shelves is continued as high as is within convenient reach, and above this point horizontal shelves are provided which will be found convenient for holding jigs, fixtures and similar articles that are seldom used, and not too heavy to be stored at that height. At the base of these cases a series of large drawers is located. They will be found very useful in storing small tools not needed on the shelves, and a variety of such articles as are best kept in such a receptacle until wanted for adding to the regular issuing assortment on the inclined shelves. In Fig. 4 is

shown a form of case of inclined shelves for longer tools than can be accommodated in the cases shown in Fig. 2. Otherwise the arrangement is the same. The ends of these cases may be conveniently used for the posting of blueprint lists of regular or standard sizes of tools in stock, from which it will be easy to ascertain if a certain tool wanted is kept on the shelves. They may be used as tool check boards, being convenient to the desk and counter. Fig. 6 shows a file case in which a regular system of arrangement of the files of different lengths, cuts and shapes are provided for, so as to make the memorizing of their location easy and convenient. It will be noticed that the smaller files, as the 3-inch, 4-inch and 5-inch files, have each one shelf provided for them, while all of the larger sizes have two shelves to each length, as more different shapes and cuts of these are required. Also, that the coarsest cut is placed at the left and the triangular, square and round shapes follow them toward the right, and that the files of each length are arranged in the same regular order. This arrangement will save much time in issuing files, as well as in distributing stock when it is received. The labels showing the shape, cut and length are placed on the edge of the horizontal dividing shelves, the *shape* being shown as in the drawing. At the base, and below convenient reach in issuing, are compartments for stock. The sizes and shapes of files shown are such as are usually needed in ordinary machine shop work. If a special class of work is done these sizes and shapes would, of course, have to be modified or added to, but the same general plan might be adhered to. As the files at the top of the case are much shorter than those lower down, a waste space will be left in the rear of them. This may be utilized by forming compartments as shown at *aa*, in which drill rods or other similar articles may be placed if such are kept in this room.

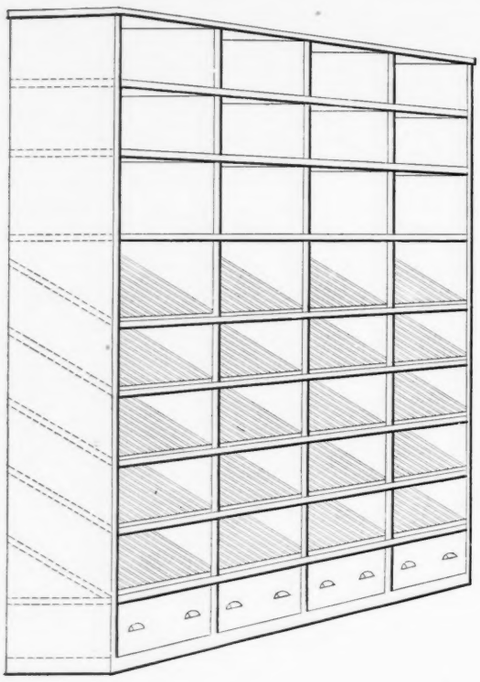


Fig. 4.

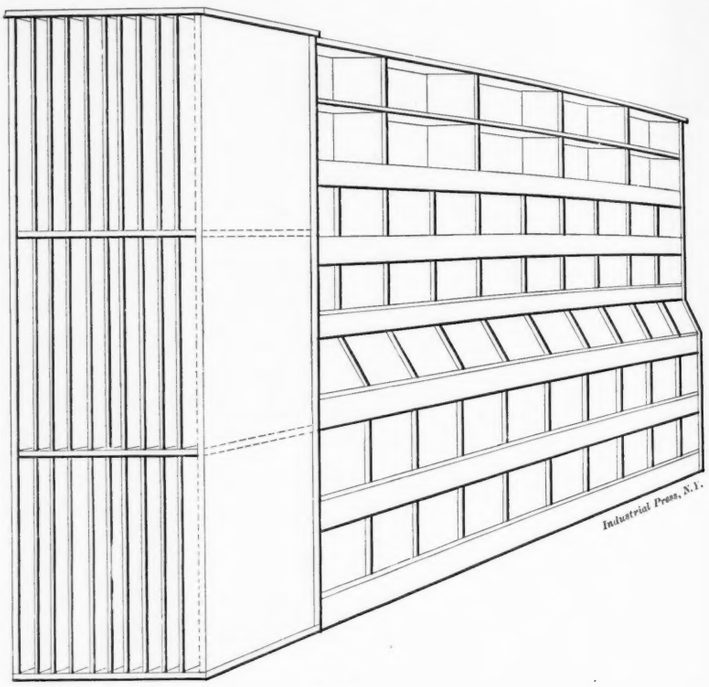


Fig. 5.

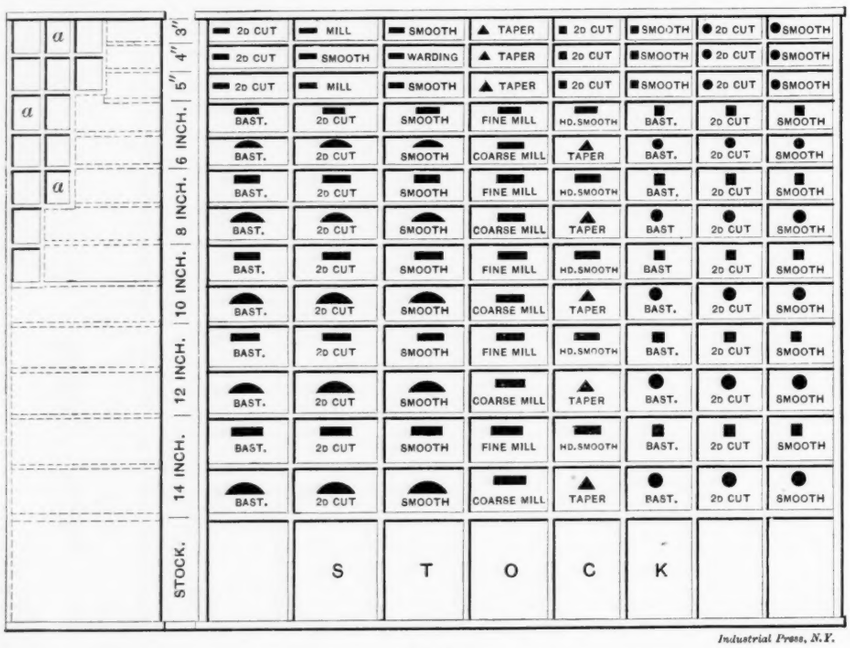

3" 4" 5" 6 INCH. 8 INCH. 10 INCH. 12 INCH. 14 INCH. STOCK.
2D CUT MILL SMOOTH TAPER 2D CUT SMOOTH 2D CUT SMOOTH
2D CUT SMOOTH WARDING TAPER 2D CUT SMOOTH 2D CUT SMOOTH
2D CUT MILL SMOOTH TAPER 2D CUT SMOOTH 2D CUT SMOOTH
BAST. 2D CUT SMOOTH FINE MILL HD.SMOOTH BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH COARSE MILL TAPER BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH FINE MILL HD.SMOOTH BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH COARSE MILL TAPER BAST 2D CUT SMOOTH
BAST. 2D CUT SMOOTH FINE MILL HD.SMOOTH BAST 2D CUT SMOOTH
BAST. 2D CUT SMOOTH COARSE MILL TAPER BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH FINE MILL HD.SMOOTH BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH COARSE MILL TAPER BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH FINE MILL HD.SMOOTH BAST. 2D CUT SMOOTH
BAST. 2D CUT SMOOTH COARSE MILL TAPER BAST. 2D CUT SMOOTH
S T O C K
Industrial Press, N.Y.

Fig. 6.

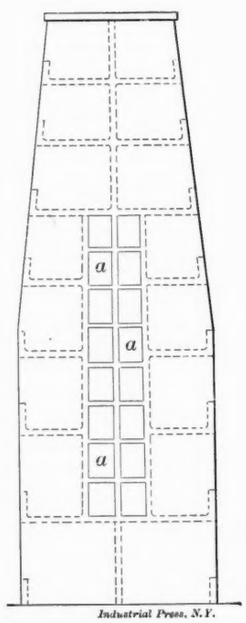


Fig. 7.

From the window opening into the machine shop a system of tool carriers, similar to the cash carriers or the package carriers of a department store, may be run to the tool distributing room near the engine room, to each of the foremen's offices, keeping out of the way of the traveling crane, and to

the galleries. These will be very useful in sending in dull tools to the tool department to be ground and in quickly returning the same. Also, in keeping these distributing points supplied with standard tools in proper condition for use. Such a system will soon save its initial cost in the time that would otherwise be spent in carrying these tools, not to consider the many delays in the work, which is usually far more important. Several matters more or less closely related to this subject will be discussed in detail in articles on the management of the work of the establishment.

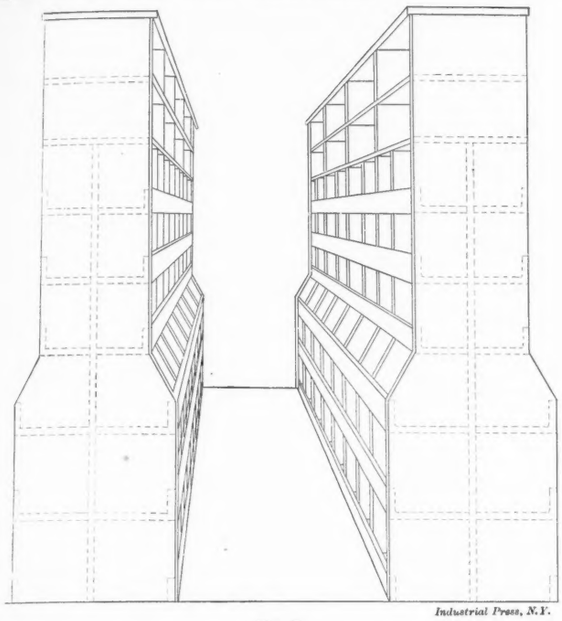


Fig. 8.

In the rough stock store room the cases are also arranged in alcoves, and are of the form shown in Fig. 8. These are made wider at the base to accommodate larger articles which are more conveniently handled at this height than higher. The construction is plainly shown in the drawing. At the upper portion plain shelves are provided to hold articles seldom used or of such irregular form as are not convenient to store in bins as arranged below. These may be constructed with a retaining strip at each side, thus forming bins all the way across the case, if the form of the articles stored renders it necessary. In Fig. 7 is shown a modified form of these cases, in which the center portion has formed in it compartments *aa*, in which may be stored round and square cold drawn steel, brass tubing and similar articles, in a safe and convenient manner and without occupying any additional floor space. Fig. 5 shows a case, the front end of which is arranged to hold such articles as sheet brass, copper or vulcanized fiber, in a similar manner to that provided for storing large window glass. This form of construction will be found better than to lay the sheets in a horizontal position, as they can be more conveniently reached, and by providing entirely separate compartments for each thickness, small pieces can be more easily cared for and readily found when wanted.

Wire in coils may be hung upon the walls. It should be so assorted and arranged that all of one material shall be together and that the smallest size is at the top, or at the left of the group.

Various modifications of these plans may be necessary in adapting the arrangements to different conditions and classes of materials to be handled, but in a general way the construction shown will be the most useful, both as to the proper storing and care of the stock, materials and tools, and as to their convenient and consequently speedy delivery when called for.

Cotton waste, or whatever equivalent is used, may be kept in a bin built under the bench, or in a similar one built under the stairs.

A small counter scale weighing up to 80 pounds and provided with a pan for weighing small articles should be provided for the counter.

The purchased parts store room is located in the office portion of the building and is arranged in a similar manner to those just described. All articles purchased outside of the shops and in a complete form to enter into the work, are here received, stored and issued. This will include all kinds of screws, bolts, hardware, belting, belt fastenings, etc. It might include files but they are here classed as tools and put in the tool store room. Oil cans, hand lamps, file cards, emery cloth, grain emery, etc., may also be kept in the tool store room, as being more nearly allied to tools than to either rough stock or purchased parts. For the same reason it might be well to place belting and belt fastenings in this room. Returning to what may strictly be considered purchased parts, the following arrangement of them will be found to be convenient and practical, both for proper storing and for issue. Machine screws should be kept in the original gross packages, on shelves not necessarily over 6 inches in width, and for the smaller sizes 5 inches apart; for the larger sizes about 9 inches apart. For eighty sorts, say from ¼ inch, 6-32 to 2 inch 24-16, and in both round and flat heads, there will be about twenty linear feet of shelving required, exclusive of vertical supports. Setscrews are also kept in the original packages on similar shelves. Thirty-four sorts, from ¼ inch x ⅜ inch to ¾ inch x 2½ inches of both oval and cupped points, will require about twenty linear feet of shelving, exclusive of vertical supports, the shelves to be placed the same distance apart as for machine screws. While the setscrews average larger than the machine screws there are only fifty in a package, against one hundred and forty-four machine screws. Setscrews with V-points, if they are of small sizes, may be kept in the original packages, but if of larger sizes, as for shafting hangers, they are best stored loose in bins. Gib screws, being of the smaller sizes, should be kept in packages or boxes. Round head and hexagon head cap screws of small sizes, say, ¼ x 1 inch to 7-16 x 1¾ inch should be kept in packages on shelves, and will occupy about the same space as setscrews. The larger sizes should be kept in bins holding about five hundred. In arranging shelf space for machine, cap and setscrews it is assumed that there will be at least three packages of each size on hand, which will be sufficient for all ordinary purposes. Special screws are usually made in large lots and are more conveniently kept in bins.

Belting may be placed under the bench at the end of the room. The rolls should be set on edge, between vertical supporting boards, and kept in place by a strip three inches high, placed on the floor in front of the rolls. In issuing belting the roll remains in place and the portion taken off is stretched along the floor and measured to the length required.

Miscellaneous hardware should be kept on shelves, and as it is seldom called for, the higher shelves will be the proper place.

Should the amount of purchased parts be larger in proportion than is here arranged for, the door leading into the general office may be omitted, thus gaining room for one more case and making one more alcove, and a door be cut through into the hall from the space inside the rail. This would add about fifteen to twenty per cent. to the storage capacity of the room.

The desks provided in these rooms should be a fixed top about 44 inches from the floor. Twenty-four inches wide will be ample. The top should be inclined to the front about 1 inch to the foot. Drawers provided with locks are fitted under this top, and below the drawers should be three shelves 12 inches wide, the first 8 inches from the floor and the others 8 inches apart. These will be convenient for storing books, blanks, etc. The space under the counters should also contain similar shelves, but these should not contain articles of regular issue to the shop.

The stock used for building bins and cases should be generally ⅞-inch pine. The divisions in the file case and in the sheet metal case need be only ½ inch thick. It is well to paint all these fittings quite a light lead color, as it is a good wearing color, and should not be so dark as to interfere with ample light. The partitions may be of the same tint up to a line 5 feet above the floor, and above that, including the ceilings, white. The same colors will be proper for the tool making department.

COPYRIGHT, 1903, BY THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1903.

NET CIRCULATION FOR SEPT., 1903,—25,183 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 or more reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 or more reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

GOVERNMENT EXPERIMENTS.

The propeller planer illustrated in this number is one of a series of very ingenious machines that have been devised by the Navy Department for use in connection with the experimental model tank at the Washington Navy Yard. There is no more important subject for investigation than that of the screw propeller, which this machine makes it possible to investigate. This is particularly true since the advent of the steam turbine in marine work, requiring propellers of unusual design, for high rotative speeds, and concerning which there is but little information available. Thirty-five years ago Engineer-in-Chief B. F. Isherwood carried on an extended series of experiments upon the subject of screw propellers, and his results are standard authority to-day. But since that time government endeavors in this direction have been of a sporadic character and the efforts of individuals have not resulted in a great increase in knowledge upon this subject. What we have gained in the intervening time has come mostly from abroad. In the matter of careful investigation the Germans have led us, and the fruits of these efforts are seen in the tremendous advances in German marine construction. In commenting on this fact Admiral Melville recently made a very frank statement, from which the following is taken:

In all probability England, France and America have each spent more money than Germany in experimental work, but German expenditure, in great part, has taken place before the article is manufactured or the ship laid down, while in the case of some rival powers, at least, the tests and experiments have been conducted instead to discover means of overcoming avoidable defects. The proverbs that "an ounce of prevention is worth a pound of cure," and that a "stitch in time saves nine" are as applicable to-day as they were in the last century. It is for this reason that the preparatory experiments of Germany have been productive of greater results than those of rival powers working in the direction of seeking remedies for existing evils. The rise of Germany as a naval power during the past thirty years has surprised the world. I believe her battleships for their tonnage are the best afloat, because they possess the triple-screw installation of machinery, thus giving the motive power of her larger warships decided economical and tactical advantages. Strangest of all, this excellence in construction is not the result of a progressive series of failures, either in design, construction, or of operation. The success of Germany can be accounted for only by recognizing the fact that study, reflection, and research must have been expended in the preparation of plans, in the building up and the organization of shipyards, and in laying out and carrying on the work of construction. It was the high appreciation of the value of original investigation, coupled with experimental work, that has caused Germany to advance successfully and progressively.

* * *

ARE THE CLAIMS FOR EDUCATION MADE GOOD?

A wise man of the West has written a pamphlet which has attracted not a little attention, to show that an academic education, such as given by our best American colleges, is not beneficial to a young man who is to have a business career. In the latter part of the pamphlet the attempt is also made to show that a technical education is also of considerably less value to its recipient than it is commonly supposed to be.

It does not make so much difference where an education is obtained—whether at home, in day school or at night school. Many have obtained liberal educations who have spent very little time behind the walls of a schoolhouse. The main advantage of the school and college, over the home or other method of study, is that the work can be completed more quickly and under proper guidance, with many facilities in the way of apparatus, models, exhibits, etc., that are nowhere available except within the school walls. Hence, an arraignment of college education is really an arraignment of education itsself, wherever obtained, and it is very pertinent to ask, Does it pay?

To the open minded no argument is needed for an affirmative answer, for it is by knowledge, and knowledge only, that advances in the world have come; but if statistics are desired, Prof. Thurston, of Cornell University, has been gathering a little information with regard to the fruits of technical education, which, all things considered, we believe, indicates that education does pay, not only in the satisfaction and pleasure that it gives, through broadened views and better grasp of affairs, but in actual dollars and cents. Prof. Thurston has reports from 1,000 graduates of technical courses, and it is fitting to ask, whether similar returns from 1,000 men who have not had technical training, but who started out at the same time that these various students did, and who were in the same condition and circumstances, would show as good results. This would give a fair test of the question of education and its value, and each reader can form his own conclusion in the matter. Prof. Thurston says:

"A list of one thousand has been prepared for me, tabulated. The average period since "graduation" is about seven years. Of these, so far as reported, one-third are holding positions of independent responsibility; one-eighth are managers and superintendents of work; ten per cent. are teaching in the professional schools and twice or thrice as many are wanted. Ten per cent are designing engineers, planning the machinery of the work shops, the manufacturing establishments, the railroads and the fleets of the country. Several are editors, one-fourth are manufacturers; many are presidents and vice-presidents of corporations, others are treasurers and the balance are distributed throughout the whole system of industries of the country. One-half of these men are not above the average age of 27 or 28 years; and 95 per cent. are not over 35 or 37. Practically all retain their connection with their profession. They commonly realize and fully appreciate their advantages, educationally.

"Of the calls which I have received for men in all grades from the 'captains of industry,' 45 per cent. are for positions worth $750 to $1,000; 15 per cent. at $1,200; 20 per cent. at $1,500; 15 per cent. at $2,000; 5 per cent. at $2,500, and in many cases from two to ten men are sought. The needs are greatest in the highest positions and where men capable of carrying large responsibility and having exceptional executive capacity find their place.

"One of the best gages of the value of these men when well suited to their profession is found in the fact that when these alumni of the engineering colleges are asked if they desire to change their present positions they almost invariably reply that they are well satisfied. Asked at what salary a change would be considered 10 per cent. of these giving definite figures propose $1,000; 30 per cent. $1,500; 30 per cent. $2,000; ten per cent. $2,500 and 5 per cent. in each grade $4,000, $5,000 and $6,000. The ablest men in highest positions usually declined to consider a change of employers or of employment."

THE ST. LOUIS EXPOSITION,

WITH REPRESENTATIVE OPINIONS FROM THOSE WHO WILL AND WILL NOT EXHIBIT.

In another part of the paper is an account of the engineering and mechanical features of the Louisiana Purchase Exposition to be held at St. Louis next year, in so far as plans have been developed and work accomplished. As yet it has not been possible to secure a list of exhibitors or of space allotments in the machinery building, for at this writing assignments have not definitely been made, except in the power department. Enough is known, however, to indicate that there will be a great show of machinery, probably surpassing in quantity that at any previous exposition, either here or abroad; but whether the machinery exhibits will equal in novelty or general interest those that have been seen elsewhere, as for example at Paris or Dusseldorf, we are not prepared to predict, although the management is very sanguine in this regard. From what we can learn we think it doubtful if it will be as representative of American machinery as could be wished; but for the mechanic and engineer not familiar with European practice, it will probably present more interesting features than any American exposition since the Centennial of 1776, because of the large assignment of space already made to foreign exhibitors, who will show machinery more or less new to Americans.

Machinery Hall is a very large building, and at the outset it was supposed that it would be ample for all requirements; but as the case now stands it is stated by a representative of the department of machinery at St. Louis that it would have been possible to have filled a much larger building and that there are now more applications for space than can be allotted.

In spite of this fact, it has been evident to us that there was a very noticeable apathy among American machinery manufacturers, especially in the machine tool trade, with respect to the St. Louis exposition. Lately more interest has apparently been aroused, largely, we judge, because of the considerable number of exhibits which have been secured from abroad through the enterprise of the management. The most important of these are of steam and gas engines, with boilers and gas producers, to the extent of 40,000 horse power, in itself a most important power installation, and one of general interest to people in this country.

Some manufacturers who have had experience at expositions, but without direct returns in the way of business, have felt that it was "crowding the mourners" to ask them to spend the time and money necessary for a display at St. Louis so soon after the expositions at Paris and Buffalo, and have frankly so stated in letters to us. On the other hand, many have secured good results from exhibits and are even enthusiastic over the opportunities this show will present for the extension of their business interests. These and other views have come to us in one way or another; and to arrive at some conclusion in regard to the sentiment among the trade, particularly the machine tool trade, we addressed a circular letter to a list of the American machinery exhibitors at Paris and Buffalo. In this the conditions as we found them were stated and we asked for opinions as to direct or indirect results from previous exhibits and also if the firm addressed was to exhibit at St. Louis. We believed that a general expression of views on this subject would be of benefit to many individual manufacturers. It has been well demonstrated that to secure the best returns a display of machinery should be a "live" exhibit, with machines turning over, and that the firm must be represented by competent salesmen and capable attendants, in order to secure results commensurate with the cost of the installation. The vital question in regard to all of this is, Does it pay? And only those who have "been there" are competent to give the answer.

Eighty-three replies were received to our letter, from firms who exhibited at Paris or Buffalo, or both, and their replies may be classified as follows:

83 exhibited at Paris or Buffalo.

43 of these have decided to exhibit at St. Louis.

28 have decided not to exhibit at St. Louis.

12 are still uncertain.

22 of those who will exhibit believe that past exhibits have been profitable.

21 of those who will exhibit are not sure about results, but are going to St. Louis, either because their competitors will be there or because on the whole an exhibit is believed to be a good advertising proposition.

We have not attempted to publish extracts from all of those heard from, but in what follows are representative expressions of opinion giving as fair a resumé of the sentiment of the trade as we are able to prepare. In the first group of "Those who will exhibit" it will be noted that some state the direct return from past expositions have been satisfactory, while others are not so sure of this, but believe in a general way that returns have come indirectly and that it is a paying proposition. A few will exhibit from "patriotic motives" and we suspect a good many because competitors are to be there. In classifying this group, we find, as stated above, that 22 out of the 43 were definitely assured of direct return from their exhibits at Paris or Buffalo.

Those who will Exhibit, because they believe Exhibits Pay.

We will exhibit at St. Louis with a "live" exhibit, as our experience at Buffalo was a very satisfactory one in both direct and indirect returns.

As a general proposition, we believe Fairs pay. We were exhibitors at Paris and Buffalo; Paris did not pay us; we think Buffalo did.

We did not have an exhibition at Paris, but did have one at the Pan-American exposition, to which we have traced some very good results. On the whole we feel satisfied with our exhibition and the results thereof.

The Buffalo exposition proved a very profitable advertising medium for our machines, and we believe we were fully justified in making the expenditure. It is our intention to exhibit at St. Louis and we shall have a "live" exhibit so far as possible.

Our exhibits in the past have brought us sufficient direct business to warrant the expense we have been to. We do not believe that a small exhibit pays, and unless we can have sufficient space we prefer to stay out.

Are pleased to say that we obtained direct and indirect results from the exhibit at Buffalo, such as we feel justified the expense incurred. It is our opinion based on our experience, that an attractive exhibit, properly looked after, and the missionary work done, and foundation laid for getting increased and new business, properly followed up thereafter, are sure to bring satisfactory results.

As regards our Chicago and Paris exhibits, we recall having received direct returns from the former, but the results from the latter were more a matter of publicity and advertisement among a new class of trade, resulting in trial orders, which we have since been following up with good prospects. We intend to exhibit at St. Louis, believing that it will pay us to do so.

We had exhibits at Paris and Buffalo, and while it is very difficult, if not impossible, to trace the direct results of such exhibits, yet on the whole we were satisfied with the results of both of these exhibits, and we looked upon the same as perhaps being a better advertising proposition than the trade papers.

At Paris our exhibit was in charge of our foreign representatives and we believe that results proved satisfactory to them. We were unable to trace many sales resulting from our Buffalo exhibit, although we believe that the general advertising received was of considerable value. We certainly had many callers and interested many people. Under proper management we are inclined to believe that an exhibit at St. Louis would repay us for its cost.

In our opinion we received sufficient returns, both direct and indirect, from our exhibits at Paris and Buffalo to warrant the expense. An exhibition of a high character places the manufacturer before many people with whom it would otherwise be impossible to get into close contact. For these reasons and prompted by a feeling of patriotic duty, we intend to make an exhibit at St. Louis.

In our line the direct results are very small indeed but we feel that an exhibit properly attended is a good investment. If it is possible for us to secure the space which we desire at St. Louis, and some one can be spared from this office to properly represent the company, we shall certainly be there with a handsome exhibit.

Our exhibit at Paris was handled through a local agent and brought us very little, if any, direct returns. Our exhibit at Buffalo, however, was under our personal supervision and we believe gave us quite a little prestige on certain machines. We undoubtedly received orders, both directly and indirectly, as a result of our exhibit, but like all other orders given on account of an advertisement we could trace only such as directly referred to our exhibit. The only thing we might add to your two questions, by way of suggestion, is that in the event of awarding medals, a different method be em-

ployed than was in vogue at Buffalo, where, apparently, any exhibitor could procure a medal. Where but one Gold Medal is awarded for each class of articles, an exhibitor would feel a natural pride in receiving such a medal.

We are strong believers in the advantages of exhibiting at such expositions as will be given in St. Louis, and we have exhibited at fourteen of the different expositions since 1874. We always prefer a live exhibit—that is, one where the machinery is running, and, if possible, producing its regular products. We think, with the exception of the New Orleans Exposition, every one of the expositions has brought us good returns and helped us to build up trade.

It is practically impossible to trace, more than in a general way, the results of making these exhibits. There is no question in our mind but that indirect returns result and warrant the expense incurred. Persons who examine exhibits of machine tools do not come prepared to place orders at the time, but an impression is made upon the party which may result in an order later on. It is one of the ways of keeping your product before the people, giving them an opportunity of examining the machine itself.

We consider that our exhibit at Buffalo brought us sufficient direct and indirect returns to warrant the expense incurred. We had power and an operating exhibit, and the expense was a heavy one. We, however, had plenty of competent, hustling, wide-awake representatives at the exhibit, and this we believe in great part made the returns. They were able and ready to take care of people who stopped and appeared interested. We kept very full records of every one whom we talked to, and we made it a point to talk to every one who stopped. These were afterward followed up.

The Chicago World's Fair was international enough in scope to pay exhibitors and we think the Paris Exposition was also satisfactory; but the one at Buffalo was more of a domestic affair and many who were there decided not to exhibit in future. We believe it is better to have an exhibit where you can show your goods to foreign buyers than to try to sell them from a catalog or samples and think the St. Louis Exposition will be much better in this respect than was the Pan-American.

We did not exhibit at Buffalo, because we could not get enough space to make a good representation of our line. We exhibited at Paris and felt well repaid, as we disposed of our whole outfit and had a good deal of trade resulting from our exhibit there. We were also large exhibitors at Chicago, and sold nearly our entire exhibit. We kept a record book with names of visitors to our space and made a number of valuable customers in foreign countries, and also sold a large bill of tools in this country. We can trace directly a great deal of benefit in the way of trade through acquaintances made at the expositions. We intend to exhibit at St. Louis and feel that it will pay manufacturers to do so if they make goods adapted to the general wants in their line throughout the world. If products are adapted to a certain locality, only, of course exhibitions cannot be of so great benefit; but we feel that there is no greater opportunity to present goods to possible buyers than at such representative expositions as the one at St. Louis promises to be. The earnestness, intelligence and straightforwardness of the heads of departments connected with the St. Louis Exposition will have much to do with encouraging manufacturers to make special efforts to exhibit there. I might add that it is shortsightedness in many exhibitors to go to a large expense to fit up fine exhibits and then place them in charge of incompetent men. They don't select as good talent to represent them as they do to prepare their exhibits, and when a possible customer comes along, seeking information regarding the special adaptability of a tool or device, he fails to find a man competent to explain it and give such information as he has come to the exposition to get.

Those who will Exhibit, but do not feel so Confident of Results.

Our exhibits at Chicago, Paris, and Glasgow have only brought in small direct results—certainly not enough to warrant the expense. Indirectly we have probably received returns, although it is only our guess.

We regard an exposition in the light of an advertisement, and it goes without saying that all advertisements in trade papers do not bring direct returns to warrant the expense incurred; but for all that, we consider it necessary to advertise, as most of the benefit of our advertising comes indirectly.

We are in doubt as to whether our Paris exhibit brought returns to commensurate expenditures; hard times set in throughout Europe subsequent to the exposition, and this somewhat counteracted the desire to purchase new tools. Did not exhibit at Buffalo. We will exhibit on a large scale in St. Louis, believing the Fair will prove successful in every way.

We exhibited at Paris and were it not for the fact that our machines were grouped with others represented by our agents, thus reducing our expense, we should have considered it quite a failure. If we had not exhibited we think we would have seen no great difference in our sales. It is our intention to exhibit at St. Louis, but our only reason for doing so is that we presume our competitors will be there also.

It is very difficult for us to tell whether or not our exhibits at Paris and Buffalo brought us any returns, or, at least, sufficient to warrant the expense that was incurred. Nevertheless, we have always believed in exhibiting at large expositions, as we secure a large amount of advertising, the results of which are undoubtedly beneficial.

As to whether our exhibits at Paris or Buffalo paid, we say emphatically, No! We look at it in this way: That while it may not pay to exhibit, in a financial sense, and while it may mean a loss in dollars and cents, our wares have an extended sale over an extended area of territory and we feel that we cannot afford not to exhibit.

As to direct results, in the machine tool line, you can hardly expect the exhibit to bring sufficient direct returns to warrant the expense. But on the other hand if you take into consideration the fact that your machines will become better known throughout the country, which will no doubt bring future inquiries and consequently orders, we think the small expense should not be considered.

We believe that all of our exhibits in the various domestic and foreign expositions have paid on the broad ground that advertising pays. We think it would be very difficult for anybody to tell just what he got out of an exposition. We have had trouble about getting our space assigned. In general, expositions are not nearly as good as they would be if space could be given out in ample season so that makers of machinery could have plenty of time to prepare their exhibits.

We must say that we are not very much in favor of expositions, but are rather forced to show our goods, as our competitors always make a good display. We went into the Paris Exposition more on account of our foreign agents, who had, during the previous years, done a very nice business for us. The depression came along soon after this exposition and since then our foreign business has been rather light. It is our intention to make quite a display at St. Louis, for we agree with you that a "dead" exhibit is of no value. We are therefore making preparations to have a large display.

Our exhibit at Buffalo did not bring us sufficient returns to warrant the expense incurred, but it is our intention to exhibit at St. Louis. Under the head of "Remarks," beg to say that a page advertisement in MACHINERY would give better returns than all the expense incurred would bring in exhibiting at one of these expositions, and at a great deal less cost. The reason of our going into these various expositions has been in almost every instance at the very urgent request of our sales agents, but where they have been asked to share the expense, we think they are about as tired of it as we are. We have been in a great many expositions for years past and this has uniformly been our experience.

At the Philadelphia Exhibition our returns, direct and indirect, were very satisfactory, but we were disappointed both in Chicago and Paris. As to St. Louis, we expect to be there; not that we expect it to pay, but because we cannot afford not to be represented. It is a strange fact that nearly all large exhibitions occur at a time when business is dull. At Philadelphia in '76, at Chicago in '93 and Paris in 1900 business was very bad in Europe and there is every probability of the same state of affairs at the time of the St. Louis Exhibition. We think the St. Louis Exhibition is coming too quick after Paris and Buffalo.

It is our intention to exhibit at St. Louis if proper space can be obtained, although our exhibit at Paris did not bring direct or indirect returns enough to warrant the expense incurred. We attribute our failure at Paris, however, to the fact that our officials at Washington have failed to sign a treaty with France that would bring us into closer commercial relations with that country. We have to pay an import duty, as the case now stands, of 3 to 7 cents a pound on machinery that we manufacture, and are thus frozen out of the French market. Another reason for loss at Paris was the exorbitant prices charged by concessioners who had bought the right to furnish the supplies and do the work required by exhibitors.

It is our intention to have space at St. Louis as we had at Paris. We do not consider that a great deal of benefit is derived from these expositions, but they serve as an advertisement, and a few customers may be secured by having machines shown off to good advantage. We recollect one rather peculiar incident in connection with the exposition in 1893 in Chicago, where the writer gave a person a catalog and some eight or nine years later he turned up with the same catalog ready to make purchases to the extent of $2,500 or $3 000, and we secured his entire order; but of course cases like this are rare. We were not benefited greatly by the Paris Exposition, and on this account neglected to have space at the Buffalo Exposition. We understand that manufacturers in general are to go into the St. Louis Exposition with good-sized spaces and we desire to do the same.

We exhibited at Paris, and the total cost, including transportation, etc., was $5,000. We believe that the results would

have been better by an expenditure of 10 per cent. of the above amount in advertising in a legitimate trade journal. We were very much disappointed in the business received from our exhibit in Paris. It is our intention to exhibit in St. Louis, provided we can get suitable space and the conditions imposed by the managers are not of such a character as will, in our judgment, interfere with our exhibit. The rumor has reached us that they propose to force all exhibitors to display their respective machines in different groups. If this is true, it will affect us disadvantageously, for we manufacture two distinct lines of machine tools, and if we should thus be obliged to have two men in St. Louis, where one ought to be sufficient, we will probably withdraw our application.

We have had a number of people mention our exhibit in Buffalo and state that they were pleased with what they saw but in most cases they were users of our machines. Exhibiting our product at any exhibition is similar to advertising in your paper or in any other mechanical journal. We feel that there is a limit to this advertising, when the returns are considered. It is a certain amount of money expended in nothing more nor less than advertising, and as you well know, it is rather difficult for us to be sure of the exact results. If we should fail to exhibit, and our competitors should exhibit, we are sure a great many people would be making inquiries as to why we were not there; and the chances are that they would be under the impression that we did not have anything of importance to bring forward, and for this reason did not care to take part. But do you not think that all of the manufacturers in this country should look at this in a broader sense and be willing to send their machinery to this exhibition, if for nothing more than to show the true American spirit? Supposing that manufacturers of all kinds of products should get together and finally decide that they were not sure the returns would be equal to the expenses and fail to send their goods to this exhibition, imagine what a condition this would be, and for this reason I think we should exhibit our machinery at St. Louis, even if our competitors actually failed to do so.

Those who will not Exhibit.

Of the 83 replies received, all from firms who exhibited either at the Paris or Pan-American expositions, or at both of these, as the case may be, 28 do not propose to exhibit at the Louisiana Purchase Exposition, and 12 are still uncertain. In a few instances, as indicated by the extracts from letters below, there are special or individual reasons why they will not take space at the coming exposition, as for example, because the character of the product may not be such as to make a live exhibit possible, except as the tools be shown in connection with other machines; or the diversity of product may be so large that an unusually large and expensive exhibit would be required to make a comprehensive display. The ruling, also, on the part of the exposition managers, that no dealers will be allowed to exhibit, but that all products must be shown by the manufacturers themselves, precludes manufacturers from exhibiting jointly, through some dealer, and thus saving a considerable portion of the expense.

For the most part, however, those who are not to be represented at St. Louis will stay away because they feel that their exhibits at Paris and Buffalo did not net satisfactory results and several express themselves very positively in this respect. One concern writes: "We have failed up to the present time to have received the first indication that either of our exhibits at Paris or Buffalo has done us one cent's worth of good." Another one says: "We are not satisfied that any exhibit we have made has brought sufficient business to pay for the expense and time." Another, "We made a showing at Paris which we have reason to believe was a pretty good one, but we have never been able to see how we have been repaid for the expense we were put to." And another, "Our experience in these matters is such that we are not over-enthusiastic." Several letters of like character were received from those who will not exhibit, which we will not take the space to publish; but below are a few extracts from communications expressing in a more varied manner the opinions of the writers and which are fairly representative of those who will rank among the stay-at-homes in 1904:

We exhibited at Buffalo and it was by all means a very unprofitable venture. It is not our intention to exhibit at St. Louis, owing to the fact that they have laid down very rigid lines which will not enable several of the smaller manufacturers to make a combined exhibit.

It is not our intention at present to exhibit at the World's Fair. It would be expensive, as we would have to maintain the exhibit independently. If we could place our exhibit in the hands of one of our representative dealers in St. Louis, who would exhibit machinery as a dealer, we would no doubt have done so.

We have always felt that in the case of the larger expositions it was a desirable thing to go to them, but this year we have not as yet decided to go to St. Louis and doubt very much if we shall do so. Such an exhibition involves a great deal, not only in the money expense but in the withdrawing from our force some of the best men for a protracted period.

Our experience with such affairs has been rather unfortunate; unprofitable from a business standpoint and unpleasant from a personal view. We believe that one-quarter of the outlay necessary to the installation and maintenance of a proper exhibit, invested in almost any other advertising proposition, and especially used judiciously among the standard trade papers, would produce infinitely better results.

Our exhibits at both the Paris and Buffalo expositions were not productive of business results that would warrant our again taking space in an exposition of like character, although, from the standpoint of "prestige" our results were flattering. For the amount of labor, time and expense involved in preparing and maintaining an exhibit of this kind, we believe the results are inadequate, or, at least, they have been so in our case.

From previous exhibits at expositions we have not received enough results to give us a fair return for the amounts expended. We believe that if we had spent the same amount of money by some other method of advertising it might have brought more returns. Lest this be considered a rather one-sided view, we will say that we believe there is no better way to advertise certain lines of manufacture than by public expositions.

I personally believe that the only persons who make money out of these big expositions are the men who draw salaries from the exposition, and that nine-tenths of the exhibitors net a loss for their trouble. This is from observation rather than from experience, although I have had some unfavorable experience of my own. I have repeatedly written the management of the St. Louis Fair that I considered the managers are the only ones who would be benefited by the exhibit.

Your favor of the 2d is received. We decided after the World's Fair in '93 that it had not paid us, and that we would not go into another American exhibition. There seems to be more effective ways of reaching the home trade for an equal expenditure of money. But we are satisfied with the results of our exhibit at Paris. Europe was a newer territory for us, which it is not so easy to cover by traveling representatives and newspaper advertising.

Our exhibit at the Paris Exposition was absolutely without profit to us. The expense was very great for a concern of the character of ours, not only in the first cost of investment, but in freights, the cost of maintenance, and various incidental items for which only the French know how to charge. A live exhibit at St. Louis would be expensive, and we believe that there is a lull coming in the machine tool trade that will extend over a long period; therefore we think there are other ways of advertising that are more desirable and profitable.

We considered at the conclusion of the Paris Exhibition that we had obtained very little satisfaction as a result of our exhibit. Our trade in France has, however, gradually increased from that time, but it is difficult to determine exactly how much of this trade is due to the Paris Exhibition. Following this we exhibited at Glasgow with very good results. We did not, however, exhibit at Buffalo, and do not propose to exhibit at St. Louis. We consider that the money expended for such exhibits in this country can be applied to better advantage in other ways.

We went to considerable expense in making and maintaining an exhibit at the Paris Exposition, but have been unable to trace any returns that would in any way warrant the expense incurred. We look at these expositions as a rather expensive means of advertising, and so far as we are able to judge it is one of the means of advertising that does not pay us, for our tools are of such a character that they must be shown in connection with other machines to be operative. Many of our tools are shown by the manufacturers of such machines, applied to the machines, where they can best be shown.

Those who are Uncertain.

As stated above, 12 of the concerns heard from in reply to our circular letter had not at the time of writing decided whether they would exhibit, the reasons for the most part being that their previous exhibits had not paid and their hesitancy in the matter springing, evidently, from a feeling that it might be a mistake not to exhibit, in spite of the expense, as long as competitors were to have displays. A few of the letters from such firms are quoted from below. Inasmuch, however, as there are more applications for space in

the machinery building than there is space to be had, it is probable that these 12, or most of them, at least, can be counted with the 28 who will not exhibit.

The Pan-American exhibit brought noticeable direct and indirect returns. An exposition is an advertisement, but we doubt, however, whether the expense was as profitable as though it had been incurred through other channels.

We are hesitating about arranging for any exhibit at the St. Louis Exposition, as we have seen no direct results from other exhibits of like kind. We believe if the same amount of money necessary to make a good display should be used in having travelers make personal calls on the trade, that far better results would be obtained.

Our experience has not been very satisfactory at previous expositions, and it is a question whether we will exhibit at St. Louis. Our direct sales at Paris probably paid the expense of the exhibit; and of course we got more or less advertising from same; but in a general way we do not think that exhibits of this kind bring direct returns enough to warrant the expenditure of both time and money.

Our impression is that we have not from a financial point of view received any great benefit either directly or indirectly from exhibits. The great majority of people who visit these fairs are not looking for business; they simply glance at what they see in passing by, and at the World's Fair it seemed to the writer that the most interest taken in general manufacture, or goods of a general character, was manifested by foreigners, largely German and Japanese.

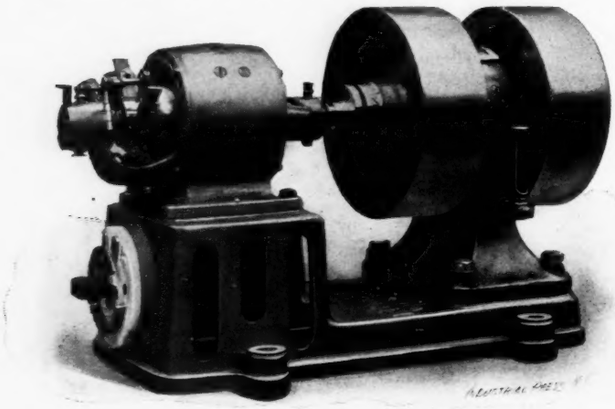
We do not feel very enthusiastic about going to St. Louis and it is uncertain whether we do so. We have exhibited in all of the principal expositions since 1873, and are unable to say whether they ever did us any good or not. The expense increases at every exposition that is held, and in our opinion the showing of goods is growing less valuable at such places, for the reason that people are getting tired of them. The first one or two expositions attracted a great deal of attention, but the interest in them is dwindling away, and it is our opinion that the principal part of the exhibitors take their wares to an exposition because they feel almost forced to do so.

* * *

A NEW GERMAN ELECTRICAL OIL-TESTING APPARATUS.

FRANK C. PERKINS.

It is very necessary where apparatus is in operation continuously and at medium or high speeds that the highest grade of lubricating oil be used. In large shops, power plants and factories where a considerable quantity of oil is required it is very desirable before purchasing to thoroughly test the oils both in order to find out the most desirable oil for the particular apparatus in use as well as to determine whether subsequent shipments are up to the standard determined upon.



Oil-testing Device, Electrically-driven.

A new electrically operated oil testing apparatus has recently been brought out by the Elektricitats-Actien-Gesellschaft, formerly W. Lahmeyer & Co., of Frankfort-on-the-Main, Germany, which is of more than passing interest. It is possible with this oil tester to accurately determine the frictional coefficient of different grades of oils at varying temperatures. It consists of a short length of shaft running in a bearing of the ring-lubricated type, and carries a heavy flywheel at each end which produces the ordinary pressure on the bearing.

A pin coupling is provided on this shaft in order that the motive power can be uncoupled at any moment while running. The apparatus is designed to be driven by an electric motor, by mechanical means or by hand. For laboratory purposes the machine is arranged with flywheels for different bearing pressures and an exact device for measuring the speed. The apparatus when electrically driven as noted in the accompanying illustration is equipped with a motor having an output of about 1-6 of a horse power, which operates at a speed of 1,800 revolutions per minute. The motor is set upon a common base plate with the oil testing machine and drives the latter by means of a pin coupling.

The machine, when mechanically operated and driven by belt, is of similar construction, having a suitable coupling for disengaging the motive power at the proper time. When the oil testing machine is hand driven, two small reduction gear spindles are arranged so as to obtain a speed of from 1,500 to 1,700 revolutions per minute at the flywheel spindle, a similar uncoupling arrangement being also provided as above.

When testing a sample of oil about one-half a pint of the lubricant is placed in the bearing and the motor is started, the flywheel shaft being run at full speed for a short time, when the motor is disconnected by means of the coupling, allowing the tester to continue running until it comes to rest. It is only necessary to note the time required for the apparatus to come to rest in order to compare the lubricating qualities of the various samples, the better the quality of the oil, of course, the longer the shaft will run before coming to rest.

When another sample of oil is to be tested, benzine is passed through the bearing in order to thoroughly clean it, and a blast of air is allowed to pass through as well, to dry it out, thus obviating the necessity of taking the apparatus apart. This method of cleaning has been found to work with perfect satisfaction after many trials of both ways.

This electrical testing apparatus is fitted with electrical resistance coils for warming the bearing to any desired temperature. A wide range of regulation can be obtained, and the frictional coefficient of various classes of oils can be tested under normal conditions of working of different types of machines.

With the mechanically driven oil testing machine, tubes are provided in the oil reservoir, through which hot water may be passed and these tubes can also be used for cooling by passing cold water through them at any desired temperature.

A method of determining whether or not the oil is likely to solidify, is to place the lubricant to be tested between two polished iron plates and laying them together, when it will be found that if the oil is at all likely to solidify it will be difficult to move the plates against one another after a short time has elapsed.

In order to test the oil to determine whether it is free from acid, it is only necessary to dip a polished copper plate into the sample for a short period of time, and note whether there is any difference between that part of the plate which was in contact with the oil and that which was not immersed.

* * *

In an article on safety mining lamps, published in the *Journal of the Franklin Institute*, Mr. Rufus J. Foster gives a history of the various schemes of lighting used in gaseous mines. Candles and various forms of lamps were early used for lighting mines, but, of course, these could not be used when the workings became foul. Under such conditions the skins of putrid fish were sometimes hung up close to the face of the coal. The slight phosphorescence of the skins enabled the miner to barely see the outlines of his work. Not so repulsive, and more interesting, were the "steel mills" used for lighting mines. These crude devices consisted of a steel wheel mounted on a shaft carrying a small pinion. Meshing with this pinion was a larger gear wheel operated by a crank, the whole being mounted in a light frame so that the machine could be easily carried about. A boy vigorously turned the crank with one hand while with the other a piece of flint was pressed against the side of the steel wheel. The result was a shower of sparks having a very slight illuminating effect, being dangerous to boot. Several disastrous mine explosions are recorded which resulted from the use of the mills. The invention of the Davy safety lamp in 1815 is one of the great benefits conferred on humanity by the inventor. It has saved countless thousands of miners' lives and made the operation of gaseous mines possible that without the Davy lamp could not be worked at all.

THE POOLE WORM-DRIVEN BORING MILL.

The half-tone, Fig. 1, illustrates an 8-foot boring mill which is one of a new line of machines that has recently been brought out by The J. Morton Poole Co., Wilmington, Del. These machines have been designed for the heavy duty that is required by the use of high-speed tool steels, and although

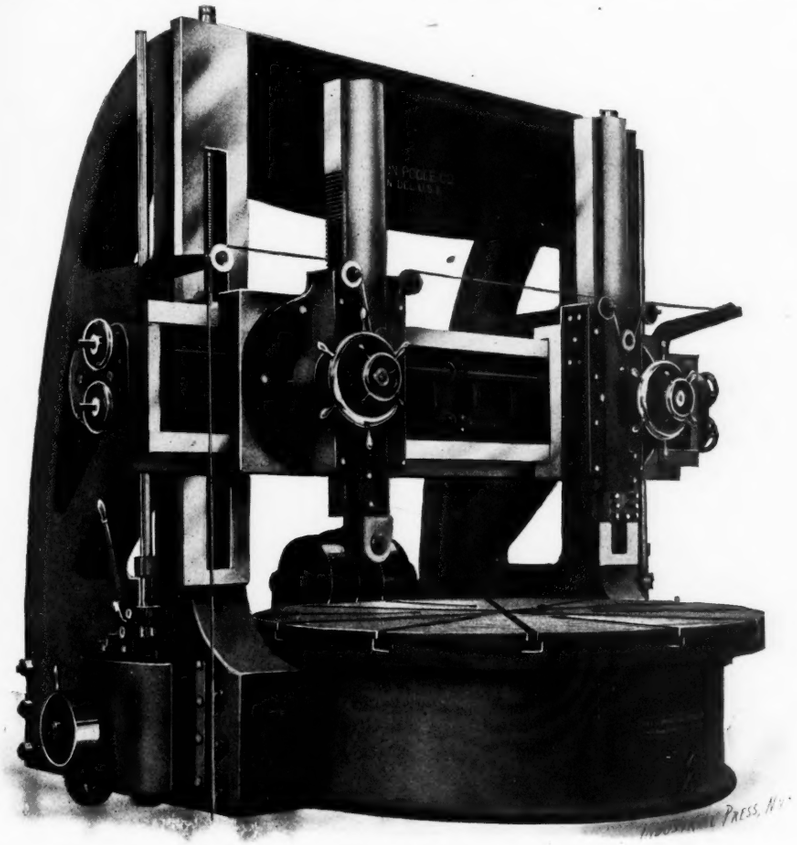


Fig. 1. J. Morton Poole Boring Mill.

the machine shown is belt-driven, provision has been made for the application of any make of motor without encroaching upon valuable floor space or bolting unsightly brackets to the bed or uprights.

The table rests upon wide flat bearings at its extreme outer edge, and is driven by a powerful "Hindley" worm wheel which is mounted on the spindle between the upper and lower bearings. This method of placing the worm wheel on the spindle, enables the operator to elevate the table from its outer bearings and take the thrust on the spindle step bearing, when running at high speeds, without destroying the alignment of the worm and wheel. The driving worm runs in an oil chamber in the bed and the table bearing is automatically lubricated by rollers located in oil pockets and held up against the bearing surface by springs.

The arrangement of the worm gear and driving mechanism is clearly shown in Fig. 2. The worm wheel, which, on this size of mill is 64 inches in diameter, has 96 teeth of 2-inch pitch. The worm, having 8 threads, thus provides a 12 to 1 gear reduction. The gears, *G* and *H*, are keyed to the back gear shaft and drive the loose friction gears, *A* and *E*. The chain gear, *T*, runs loose on the back gear shaft and carries the pinion *L*, which drives the back gears, *U*, *S*, and *R*, the latter running loose on the shaft. The chain gear can drive the back gear shaft direct, by operating the friction clutch between *G* and *T*, or a back gear ratio of 8 to 1 can be obtained by engaging the clutch, *O*, which is keyed to the shaft with the hub of gear *R*. The cone pulley has three steps for 6-inch belt, and a 3-inch Morse silent chain transmits the power from the cone shaft to the back gear shaft. This arrangement of gearing gives back gear ratios of 12, 36, 95, and 285 to 1. When a two-speed friction countershaft and three-step cone pulley are used, 24 table speeds are available, and either series of eight speeds can be obtained without shifting the belt or stopping the machine. The various speeds are obtained by a lever and hand wheel conveniently located at the right of the machine.

In Fig. 3 is shown the feed box with the cap removed. On each end of the main worm shaft is a feed worm, *B*, driving the worm wheel, *C*, which is keyed to the hub of the pinion *D* running loose on the shaft. Gear *F* is also loose on the shaft and is driven from *D* through the gears *I* and *J*, which are loose on the other shaft and give a feed back gear of 8 to 1. Either *D* or *F* can be engaged with the shaft by means of a sliding key operated by the lever *B'* upon shaft. Gears *K*, *M*, *N*, and *P* are keyed to the shaft and drive the four loose gears, *Q*, *V*, *W*, and *X*; any one of which, or the rapid traversing spiral gear, *Y*, can be engaged with the shaft by the lever *C'* and a sliding key running in a slot in the shaft. Spiral gear *Y* is driven at a constant speed, through the gear *Z* and the shaft *A'* by the pulley and gears shown at the left of the machine in Fig. 1. By these various combinations of gears we may obtain 8 feeds from 1-64 to ¾ inch, and a quick traverse of the crossheads in or out, and the tool bars up or down, at a rate of 8 or 13 feet per minute, and it is impossible to throw in any of the feeds while traversing. The feeds and traversing speeds are reversed in the gear boxes on the ends of the cross rail, by means of small hand wheels. Both feeds and speeds of each head are entirely independent and can be applied at any angle at which the swivel heads may be set.

A lever in front of the right-hand upright controls a friction clutch for elevating and lowering the cross

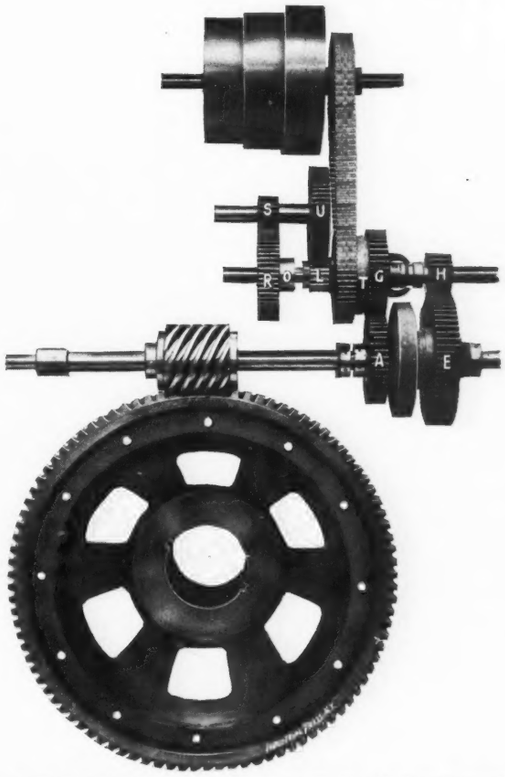


Fig. 2. Worm Drive for Table, with Morse Chain and Gear Connections.

rail at a rate of 4 or 7 feet per minute, and this arrangement dispenses with the usual pulley, bevel gears, brackets and shaft that are generally placed on the top of a boring mill. The usual chain connection for the tool slide counterbalance has also been replaced by a wire rope.

When it is desired to make the machine motor-driven, a small constant speed motor is attached to the left upright for

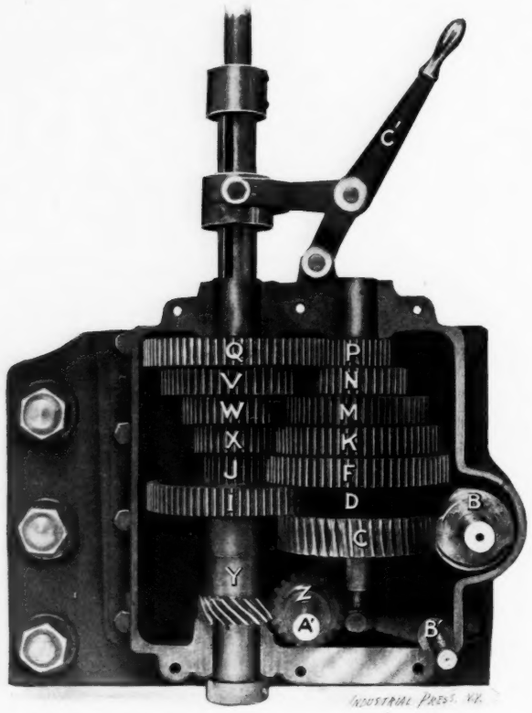


Fig. 3. Feed Box for Boring Mill.

the power traveling of the heads, tool bars and cross rail, and a variable speed motor is bolted to the bed in place of the cone pulley, shaft and brackets. A silent chain pinion, of the proper size to give the correct back gear speed, is keyed to the motor shaft and the rest of the driving mechanism remains exactly as illustrated for the belt drive.

* * *

Mr. W. P. Atwell, the U. S. consul at Roubaix (in Northern France) says that American machinery and labor-saving tools are making great headway in that great industrial district. American agricultural machinery, tools, etc., are being used extensively and with great success. There is a large demand in the district for all kinds of American machinery, tools, hardware, typewriters, desks, farming implements, stoves, motor cars, bicycles, novelties, etc. The sales of such goods should be intrusted to general agents who understand the language and trade methods of the French. Printed advertising matter is useless unless printed in French. Goods should be securely packed, and all weights and measures should be quoted in the metric system. German imitations of American machinery are sold there as the genuine, but at very low prices.

* * *

In a little periodical called *The Corbin*, issued in the interests of a lock-making concern, a small East Indian padlock was recently illustrated and described. To unlock it requires four distinct operations. First, a thumbscrew has to be turned by which a bail is drawn down revealing a hole into which a screw-bitted key is inserted and turned until a spring throws back a front plate and reveals the keyhole. Two keys are required to unlock, one being inserted after the other and each drawing a separate bolt. The locking is the reverse of this tedious operation which leads the writer of the description to remark: "The lock is an ingenious one and may answer in a land where time is reckoned by centuries and an hour is a mere nothing, but in this country of the split-second watch and mile-a-minute train, the ordinary citizen has no time to spend in turning three keys and a thumbscrew to open a single lock. He would be likely to use an axe instead."

BOILER BRACING.—2.

CALCULATIONS FOR THROUGH STAYS.

CHARLES L. HUBBARD.

High pressure boilers and those of large size are usually provided with through braces. Sometimes two or three through braces are placed in line across the head, a short distance above the tubes, and the upper part of the segment is supported by crow foot braces. When through braces are used in the upper part of heads they interfere seriously with the inspection of the boiler. Aside from this, the method of through bracing is preferable to any other, as it does away with all pins or bolts. The braces are straight steel rods, without welds, and an even tension can be secured upon all of the braces, which is very difficult, if not impossible, in the case

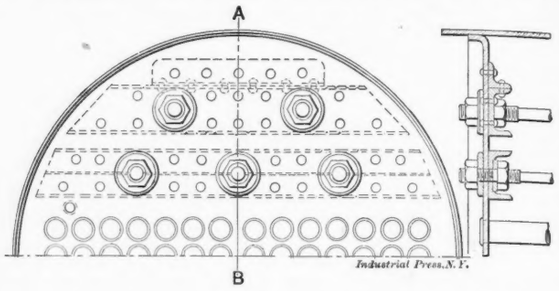


Fig. 1. Fig. 2.

of diagonal braces. For boilers 66 and 72 inches in diameter, five through braces may be used, and, if properly spaced, allow sufficient room for inspection. Boilers 60, 54 and 48 inches in diameter may have a combination of through and crow foot bracing. Below 48 inches they are mostly used for heating purposes or for running small engines at comparatively low pressures, and crow foot bracing will be found sufficiently strong. Through bracing consists of rods passing through the entire length of the boiler, with heavy nuts and washers at the ends on the outside, and check nuts on the inside. Stiffening pieces of channel or angle iron are riveted to the heads to support them.

Fig. 1 shows the general arrangement of the channels and braces, and Fig. 2 a section on line *A B*. The upper bar in this case consists of a channel iron with an angle riveted to its upper flange to give it greater strength. The lower bar is made up of two angles riveted to the head, as shown.

Where angles are used instead of a channel, it is necessary to countersink slightly around the holes for the braces, to give a solid bearing for the washer and check nut. The outside washer is sometimes made of copper slightly cup-shaped on the under side in order to give a tight bearing around the

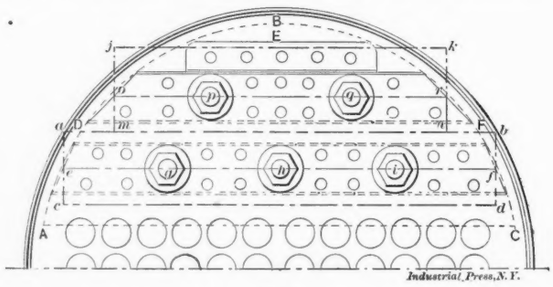


Fig. 3.

edge. It is more common, however, to use heavy cast-iron washers and embed them in red lead to make them tight. When channel bars will give the required strength, they are preferable to angles for stiffening pieces, but for high pressures the standard weights will, in many instances, be found too light, and resort must then be made to angle irons, of which there is a great variety of sizes and weights to choose from. In this form of bracing the channel bars act as beams, carrying the loads due to the pull on the rivets, and the beams in turn are supported by the rods. The general method of designing through bracing, which is given here, can be found in "Steam Boilers," by Professors Peabody and Miller. We shall take it up here more in detail in order to refreshen the

reader's mind on certain points which come more strictly under the head of mechanics. Referring to Fig. 3, let us take up the different steps in detail. The area to be supported is found in the way already described in a previous article and is shown by *A*, *B* and *C*. The rivets for fastening the head to the channel bars are laid out as nearly as possible in equi-distant rows; the maximum distance between them being checked by the formula already given for this purpose. In practice they are usually placed from 4 to 5 inches apart. The load carried by each rivet is then computed the same as for crow foot bracing, and the size is made such that the stress shall not be more than 6,000 pounds per square inch. No rivet should be placed nearer than 3 inches to the shell or tubes on account of the straining effect due to expansion. Channel bars of suitable width are then drawn in, and the stays, usually five in number, are laid out, leaving sufficient space (not less than 19 or 20 inches) between the two upper ones for access to the boiler.

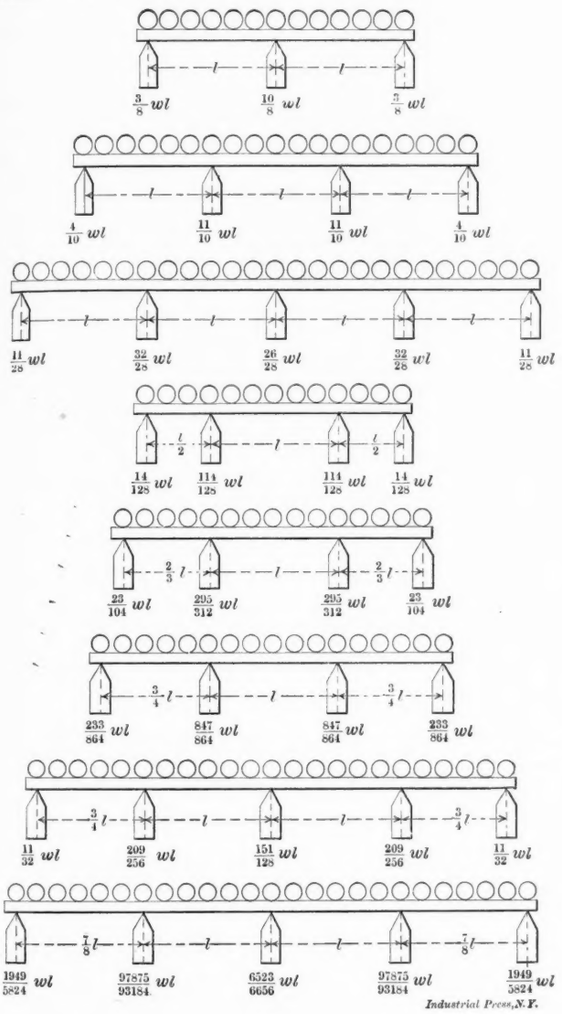

$\frac{3}{8}wl$ $\frac{10}{8}wl$ $\frac{3}{8}wl$
$\frac{4}{10}wl$ $\frac{11}{10}wl$ $\frac{11}{10}wl$ $\frac{4}{10}wl$
$\frac{11}{28}wl$ $\frac{32}{28}wl$ $\frac{26}{28}wl$ $\frac{32}{28}wl$ $\frac{11}{28}wl$
$\frac{14}{128}wl$ $\frac{114}{128}wl$ $\frac{114}{128}wl$ $\frac{14}{128}wl$
$\frac{23}{104}wl$ $\frac{295}{312}wl$ $\frac{295}{312}wl$ $\frac{23}{104}wl$
$\frac{233}{864}wl$ $\frac{847}{864}wl$ $\frac{847}{864}wl$ $\frac{233}{864}wl$
$\frac{11}{32}wl$ $\frac{209}{256}wl$ $\frac{151}{128}wl$ $\frac{209}{256}wl$ $\frac{11}{32}wl$
$\frac{1949}{5824}wl$ $\frac{97875}{93184}wl$ $\frac{6523}{6656}wl$ $\frac{97875}{93184}wl$ $\frac{1949}{5824}wl$
Industrial Press, N.Y.

Fig. 4.

It is common to use 7-inch channels, or their equivalent, in angles, for 72 and 66-inch boilers; 6-inch channels for 60 and 54-inch boilers, and 5-inch for 48-inch boilers. It is only necessary to assume a width at this stage of the problem in order to arrange the rivets and stays; the weight of the bars can be computed later. The next step is to determine the required size of the stays or braces. The area to be supported by the lower stays may be taken as that of a strip or rectangle bounded on the bottom by the line *c d*, half way between the lower line of rivets in the lower channel and the line *A C*, and bounded at the top by the line *a b*, half way between the lower rivets in the upper channel and the upper rivets in the lower channel.

The ends of the rectangle are formed by the vertical lines *a c* and *b d* drawn through the extremities of the center line of the channel at *e* and *f*. This strip is commonly provided with

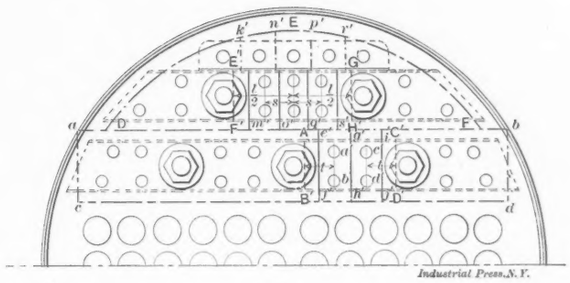


Fig. 5.

three stays in boilers from 54 to 72 inches in diameter, and with two in 48-inch boilers, although different engineers may vary this arrangement somewhat.

The strip may now be treated as a continuous girder. Where a uniformly loaded beam passes over more than two supports, the rules applying to simple beams no longer hold, as new forces and conditions are introduced. By a somewhat complicated process, values have been computed for the loads acting on the various supports for different arrangements of spacing. These results are shown in the diagrams, Fig. 4.

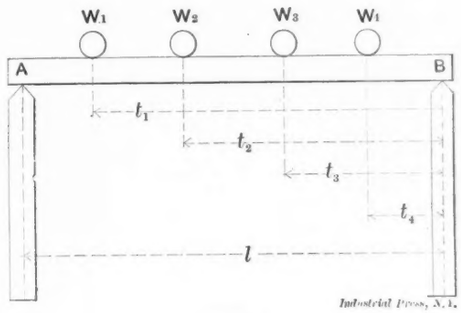


Fig. 6.

In all cases w is the load per unit of length; that is, if l is taken in inches; then w is the load per inch in length of the beam, and equals, of course, the total load divided by the length of the beam.

Referring to Fig. 4 we find for the case of a continuous girder with five equally spaced supports, that the greatest loads are carried by those next to the ends and are equal to $\frac{32}{28}$ w l pounds each. w being the load per unit length, is evidently equal to the width of the strip in inches multiplied by

TABLE I.

Diameter of Rod.	Area of Section in inches.	Weight of Rod per foot.	Diameter of Upset Screw Ends.	Threads per inch.	Thickness of Nuts.
$\frac{3}{4}$	.4418	1.47	1	8	$\frac{3}{4}$
$\frac{13}{16}$	.5185	1.72	$1\frac{1}{8}$	7	$\frac{13}{16}$
$\frac{7}{8}$	.6013	2.00	$1\frac{1}{4}$	7	$\frac{7}{8}$
$\frac{15}{16}$	.6903	2.30	$1\frac{1}{4}$	7	1
1	.7854	2.61	$1\frac{3}{8}$	6	1
$\frac{1}{8}$	.9940	3 31	$1\frac{1}{2}$	6	$1\frac{1}{8}$
$\frac{1}{4}$	1.227	4 09	$1\frac{5}{8}$	$5\frac{1}{2}$	$1\frac{1}{4}$
$\frac{3}{8}$	1.484	4 95	$1\frac{3}{4}$	5	$1\frac{3}{8}$
$\frac{1}{2}$	1.767	5 89	2	$4\frac{1}{2}$	$1\frac{1}{2}$
$\frac{5}{8}$	2.073	6 91	$2\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{5}{8}$
$\frac{3}{4}$	2.405	8.01	$2\frac{1}{4}$	$4\frac{1}{2}$	$1\frac{3}{4}$
$\frac{7}{8}$	2.761	9.20	$2\frac{3}{8}$	$4\frac{1}{2}$	$1\frac{7}{8}$
2	3.141	10.47	$2\frac{1}{2}$	4	2
$\frac{1}{8}$	3.546	11.82	$2\frac{5}{8}$	4	$2\frac{1}{8}$
$\frac{1}{4}$	3.976	13.25	$2\frac{7}{8}$	4	$2\frac{1}{4}$
$\frac{3}{8}$	4 430	14.77	3	$3\frac{1}{2}$	$2\frac{3}{8}$
$\frac{1}{2}$	4.908	16.36	$3\frac{1}{8}$	$3\frac{1}{2}$	$2\frac{1}{2}$
$\frac{5}{8}$	5.411	18 04	$3\frac{1}{4}$	$3\frac{1}{2}$	$2\frac{5}{8}$
$\frac{3}{4}$	5.939	19.80	$3\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{3}{4}$
$\frac{7}{8}$	6.491	21.64	$3\frac{5}{8}$	$3\frac{1}{4}$	$2\frac{7}{8}$

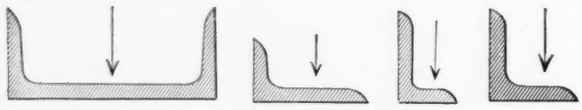
the boiler pressure per square inch, and l is the distance, *eg*, *gh*, etc., between the supports in inches. Having found the greatest load carried by any of the lower stays we then proceed to do the same for the upper ones before calculating the required size.

The area to be supported by the upper stays is that of the segment, *D B F*; This area may be computed by the rule already given. Next construct a rectangle by drawing vertical lines *j m* and *k n* through the extremities of the center line of the upper channel, at the points *o* and *r*, making the height *j m* such that the area shall equal that of the segment just found. Treat this as a continuous girder with four supports. If the stays are spaced so that the distance *o p* equals two-thirds of *p q*, then we shall find from Fig. 4 that the greatest loads are carried by the supports at *p* and *q*, and are each equal to

$\frac{295}{312}$ *w l*, in which *w* equals the width *j m* of the rectangle multiplied by the boiler pressure, and *l* is the distance *p q*.

TABLE II: GIVING PROPERTIES OF CHANNELS AND ANGLES.

[In the following are the moments of resistance and other properties for different sizes and weights of channels loaded as shown in the accompanying sketches.]



CHANNELS.

Size.	Width of Flange.	Thickness of Web.	Weight per foot.	Moment of Resistance.
7	2 09	.21	9.75	.63
7	2.19	.31	12.25	.71
7	2.46	.36	14 75	1.03
7	2.56	.46	17.25	1.13
7	2.67	.57	19.75	1.23
6	1.92	.20	8.00	.49
6	2.14	.27	10.50	.68
6	2.27	.40	13.00	.78
6	2.39	.52	15.50	.88
5	1.75	.19	6.50	.37
5	1.88	.32	9.00	.46
5	2.03	.47	11.50	.53
4	1.58	.18	5.25	.29
4	1.64	.24	6.25	.32
4	1.72	.32	7.25	.35

ANGLES WITH EQUAL LEGS.

Size.	Thickness.	Weight per foot.	Moment of Resistance.
3½ x 3½	13/16	17.1	2.25
3 x 3	15/16	13.7	1.84
3 1/16 x 3 1/16	5/8	11.5	1.39
3 x 3	5/8	11.4	1.30
3½ x 3½	9/16	8.5	1.15
3 x 3	9/16	8.6	1.02
3½ x 3½	5/16	7.1	.98
2½ x 2½	1/2	8.5	.89
2½ x 2½	1/2	7.8	.75
2½ x 2½	7/16	7.7	.73
3 x 3	7/16	4.9	.58
2¼ x 2¼	7/16	6.8	.58
2 7/16 x 2 7/16	3/8	5.4	.50
2¾ x 2¾	5/16	4.5	.48
2¼ x 2¼	5/16	4.1	.40
2 5/16 x 2 5/16	5/16	4.8	.40
2 x 2	5/16	5.3	.40
2½ x 2½	1/4	3.7	.32
2½ x 2½	3/16	3.1	.30

ANGLES WITH UNEQUAL LEGS.

Size.	Thickness.	Weight per Foot.	Moment of Resistance, Load Perp. to Longer Flange.	Moment of Resistance, Load Perp. to Shorter Flange.
4 x 3½	13/16	18.5	2.30	2.92
3½ x 3	13/16	15.7	1.65	2.20
3 1/16 x 3 5/16	5/8	12.9	1.53	2.00
3½ x 2½	11/16	12.4	.99	1.85
3¾ x 2¾	1/2	9.4	.88	1.58
4 x 3½	9/16	9.1	1.18	1.50
4 x 3½	5/16	7.7	1.00	1.27
3¼ x 2¾	1/2	8.7	.88	1.20
3 x 2½	5/16	9.5	.82	1.15
3⅝ x 2½	3/8	6.6	.41	1.09
3 x 2	1/2	7.7	.47	1.00
3½ x 3	5/16	6.6	.72	.96
2 13/16 x 2 15/16	1/2	7.0	.60	.88
3½ x 2½	7/16	4.9	.41	.75
3½ x 2	7/16	4.5	.27	.72
2½ x 2	7/16	6.8	.46	.70
2¼ x 1½	5/16	5.5	.26	.59
3 x 2½	7/16	4.5	.40	.56
3 x 2	7/16	4.1	.26	.54
2 7/16 x 1 11/16	5/16	4.4	.24	.46

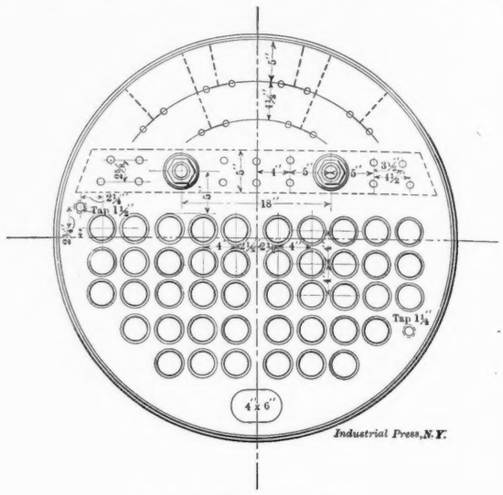


Fig. 7. Forty-eight inch Boiler.

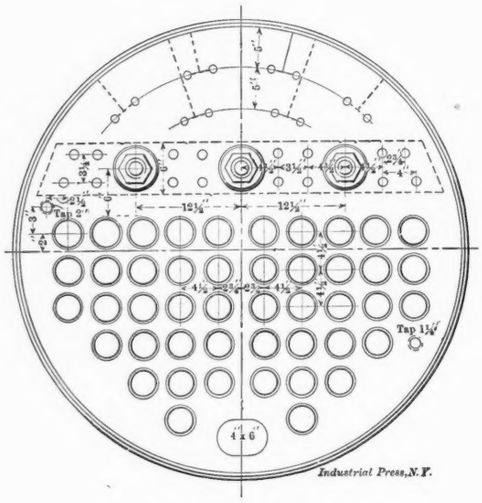


Fig. 8. Fifty-four inch Boiler.

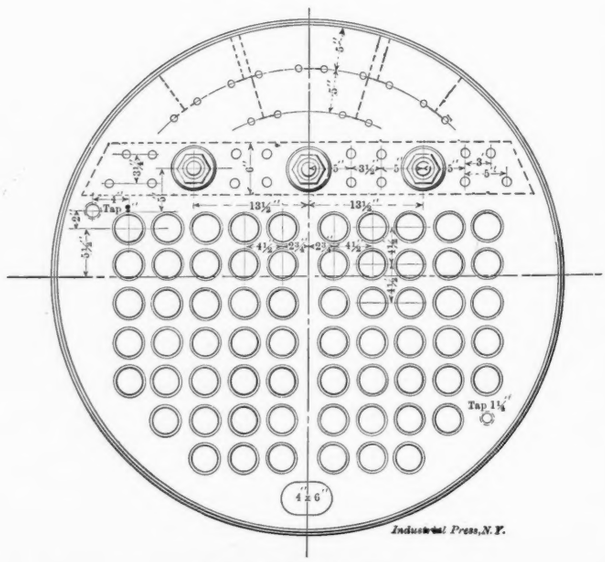


Fig. 9. Sixty-inch Boiler.

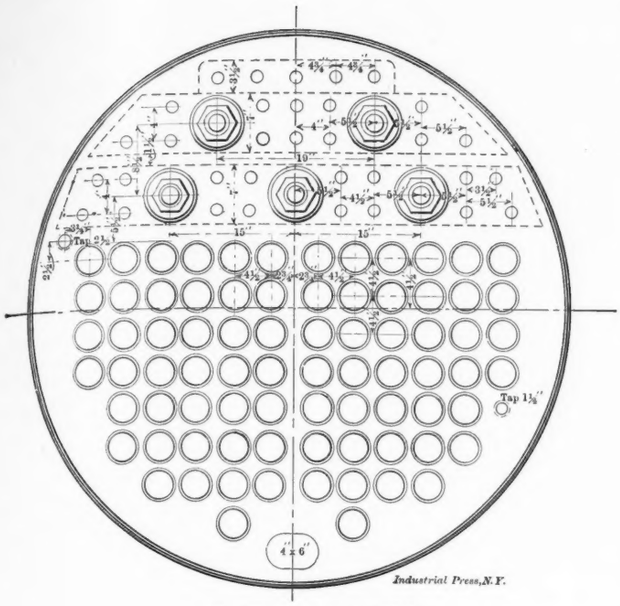


Fig. 10. Sixty-six inch Boiler.

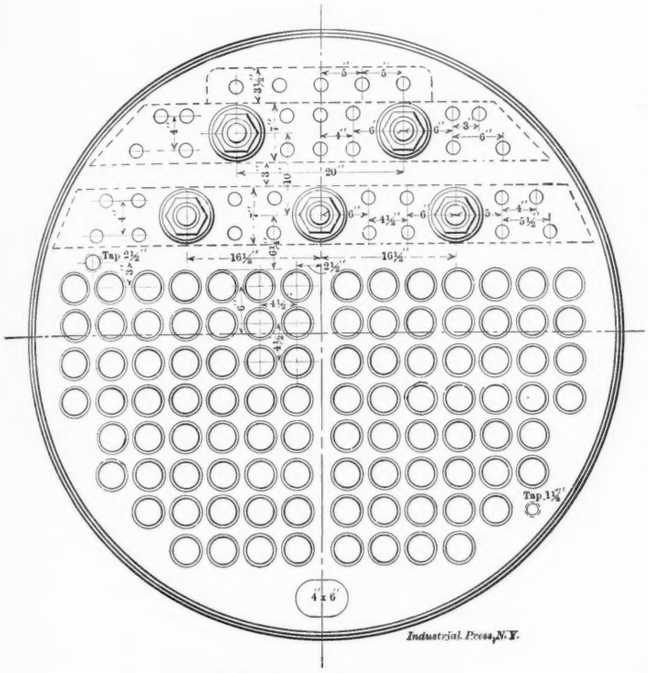


Fig. 11. Seventy-two inch Boiler.

In computing the required size of the stays we may allow a stress of 10,000 pounds per square inch for mild steel. By taking the greatest load found for any one stay and dividing it by 10,000, we have the required area of section in square inches, and the corresponding diameter can be found at once from a table of areas. The ends of the stays should be upset so that the diameter at the root of the thread shall be as great or greater than the body of the stay. If an allowance is to be made for corrosion it can be added directly to the diameter thus found. The working load is sometimes fixed by government rules or by insurance companies, and may vary somewhat from the above, but the method of computation will be the same in any case.

Table 1 will be found useful in proportioning the stays, nuts, etc.

In computing the required strength of the lower channel the maximum bending moment must first be found. This is done by taking a section of the bar, cut by the lines A' B' and C' D' (Fig. 5), drawn ¼ the diameter of the large washers from their centers, and treat it as a simple beam supported at both ends and carrying two loads symmetrically placed. The loads are each equal to the area supported by a pair of rivets, multiplied by the boiler pressure per square inch. The area supported by a pair of rivets, as a' b', is taken as that bounded by lines drawn half way between the rivets and the adjacent points of support, for example, e' g' is half way between the upper line of rivets in the lower channel, and the lower line in the upper channel, and g' h' is half way between the rivets a' b' and c' d', etc. In the case of a beam loaded as above, the maximum bending moment $M = \frac{Wt}{2}$, in which $\frac{W}{2}$ is the load on a pair of rivets, and t is the distance of the rivets from the line of support, A' B'.

Having determined the value of M for any given case, the "moment of resistance" can be found from the relation $\frac{M}{f}$ = moment of resistance, in which f is the safe working stress in the outer fibers of the beam. In the case of rolled steel beams used in this manner it is common to assume a safe working stress of 16,000 pounds per square inch.

In the case of the upper bar the channel and angle iron are riveted together and treated as a single beam supported at both ends and having three loads symmetrically placed. Under these conditions the maximum bending moment,

$$\mathrm{M} = \left(\frac{l}{2} \times \frac{W}{2}\right) - (s \times w) \text{ in}$$

which W = the total load, which is equal to the area m', k', r', s', multiplied by the steam pressure per square inch, w = the load on area q', p', r', s', l=the distance between the points of support or the distance between lines E' F' and G' H', s = the distance between the rows of rivets as shown.

The supporting lines E' F' and G' H' are drawn ¼ the diameter of the large washers from their centers and the loads as before are taken as equal to the area supported by a vertical row of rivets, multiplied by the boiler pressure. The supported areas are divided by lines drawn half way between the points or lines of support, as already described. The moment of resistance is computed from the bending moment and suitable sizes of channel and angle bars are selected and riveted together to give the required strength.

If the required moment of resistance is greater than any found in the table for channels the bars must be made up of angles taken from Table II.

In case the rivets in either the upper or lower channel are not symmetrically placed, the position and amount of the maximum bending moment may be found as follows, by comparing it with a beam with any number of loads *not* symmetrically placed.

Knowing the weights of the loads, W_1, W_2, W_3, etc., in Fig. 6, the first step is to determine how the total load is divided between the points of support, A and B. This may be done by considering the beam hinged at one end, as at B, and carrying the loads W_1, W_2, W_3, etc., with a resisting force or support at A. As the bar remains stationary, it is evident that the forces tending to rotate it in one direction about B must be just equal to those acting in the opposite direction. In other words, the moment $Al = W_1t_1 + W_2t_2 + W_3t_3 + W_4t_4$, from which equation the value of the force represented by A can easily be found. Knowing the resisting force at A, that at B can be found by subtracting A from the total load. To find the point where the maximum bending moment occurs, begin at B and take the sum of the loads, $W_4 + W_3$, etc., until a quantity is obtained which is equal to, or greater than, the resistance just found at B. The point at which this last load acts is the position of the maximum bending moment. For example, suppose $W_4 + W_3$ is less than B, and $W_4 + W_3 + W_2$ is greater, then we know the greatest bending moment occurs at W_2, or strictly speaking, somewhere between W_3 and W_2. Taking the sum of the moments about W_2, we have for the value of the maximum bending moment a quantity $= Bt - [W_3 (t_1 - t_3) + W_4 (t_2 - t_4)]$.

Figs. 7, 8, 9, 10 and 11 give detail drawings of boilers of various sizes designed by the foregoing methods to carry a working pressure of 100 pounds per square inch, and will be found useful for comparison in the design of new work. It has been assumed in all cases that the heads are not less than ½ inch in thickness.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The steamship *Deutschland* broke all ocean records when she reached Quarantine in New York Harbor, September 8, having made the westward trip in 5 days, 11 hours and 54 minutes. This beats her best previous run by 69 minutes and the best record of the *Kronprinz Wilhelm* of the North German Lloyd line, by 3 minutes.

On July 14, 1903, the Great Western Railway made a record run from Paddington to Plymouth, England—a distance of 245.75 miles in 234 minutes—without a stop. The train consisted of five cars, weighing 125 tons; the weight of the locomotive is 54 tons and that of the tender is about 35 tons. The average speed for the entire distance is 63 miles per hour.

A ten-car Manhattan Beach train was recently run on the elevated lines, Brooklyn, New York, to take the New York Twenty-third Regiment on an excursion. This was the longest train that has been run on an elevated road. It was made up of ten motor cars. Each car had four 60-horsepower motors—forty motors in all. These forty motors were all connected on the circuit, giving the train a propelling power equal to 2,400 horse power.

The hulls and machinery for the five battleships for which Congress made an appropriation for the fiscal year, commencing July 1, 1903, will cost, when completed, about $20,000,000, and the armor, armament and equipment will require an additional outlay of $1,500,000. The annual depreciation of these vessels, taking into consideration their wear and tear as well as their fighting value, is estimated to be at least 4 per cent., or a total of nearly a million and a half dollars; and this is exclusive of the running expenses of these expensive attributes of the "majestic arm of the law."

In the paper "Axle Lighting" read before a recent meeting of the American Institute of Electrical Engineers by Mr. Elmer E. Sperry the statement was made that in August, 1882, the Pennsylvania R. R. electrically equipped car No. 397 with Faure accumulators imported for the purpose from France. Not only is this the earliest application of electricity to car lighting in this country, but in the world. The first installation of solid electrically illuminated trains, is that of the Pennsylvania Limited, between New York and Chicago, in the middle eighties. These are still in continuous service and all are direct-connected sets in the baggage compartment, supplying the lamps and the storage batteries beneath each car.

The United States Consul at Frankfort, Germany, says that the German papers report the discovery by Mr. Edward Mollard, a Frenchman, of a new metal called "selium." The discoverer, it is said, claims that selium costs but one-twelfth as much as aluminum and is lighter and stronger. It does not rust, and is therefore suitable for use in shipbuilding, for the manufacture of pipes, and for railroad construction. On account of its cheapness—and as it is capable of a fine polish, resembling nickel—it would be desirable for manufacturing cooking utensils. Its density is 2.6, and its hardness not quite that of iron, but greater than lead or zinc. Its power of resistance is said to be greater than that of iron, but less than that of steel. The melting point is high, being about 2900 degrees Fahr. In melting, it contracts somewhat, but molding in forms is not impossible.

The *Scientific American* illustrates and describes what is said to be the largest transformer in the world. It was built by the Stanley Electric Manufacturing Co. for the Pittsburg Reduction Co. to be used in their Niagara Falls plant for the manufacture of aluminum. The transformer is of 2,000 kilowatt capacity. The primary circuit receives current from the Niagara Falls of 908 amperes at 2,200 volts. This current is "stepped down" in the secondary winding to 40,000 amperes at 50 volts, the manufacture of aluminum requiring a powerful current of low voltage. The transformer measures 7 feet, 2 inches square at the base and is 8 feet, 8 inches high. The coils are oil cooled, being incased in a tank which is filled with heavy mineral oil. The heat absorbed by the oil is in turn absorbed by a coil of pipe in the top through which is circulated cold water.

Petroleum was first used for road purposes in California in 1898, solely for the purpose of laying the dust, which, during the long dry seasons, become a serious nuisance if not a menace to life and property. It was soon discovered, however, that not only does the petroleum serve the purpose of making dustless roads, but it immediately begins to bind together the loose particles constituting the road surface, whether clay, sandy loam, loose sand, gravel or fine material on top of macadamized roads. A tough stratum is formed, resembling asphalt pavement. Roads built on drifting sand or clayey dust, no matter how deep, where trotting with a buggy was impossible and for a pair of strong horses to pull a ton was a very laborious process, became indurated, resilient, and firm, so that driving teams could trot with ease and the same pair of horses pull 2½ tons more comfortably than they formerly did one ton. Petroleum having a large percentage of asphalt in suspension as have the heavy oils of California and Texas, is best for road-making purposes—and cheapest.

The proposed race of airships at the St. Louis Exposition has done much to stimulate the invention and production of motors of extremely light weight, and, according to the *Scientific American*, a gasoline motor has been constructed by the Walters Power Company, Jersey City, which is the lightest on record for an engine of this type. The contract stipulated that the motor alone should weigh not more than 26 pounds and should yield at least 2 horse power. The completed motor comes well within these requirements, having a weight of about 24¼ pounds and an output of 2¼ horse power. Even with the addition of the carbureter, the weight is but 25½ pounds. In the construction of the motor aluminum is used wherever possible, and the other parts are made as small and compact as practicable. The general design, however, closely follows standard lines. The motor is of the four-cycle type and the cylinders have a 2⅛-inch bore by a 2 7-16-inch stroke. One feature which is particularly noticeable is the absence of radiating ribs on the main body of the cylinders. It was found that the heat of the cylinders could be dissipated with sufficient rapidity from the smooth surface of the cylinder. However, in order to insure sufficient strength the ribbed formation is retained on the cylinder heads and the valve casings, for at these points the pressure is the greatest.

Much interest is evinced in engineering circles by the approval of the Naval Board of Construction of Rear Admiral Melville's report recommending that one of the new scout ships to be constructed for the government should be equipped with steam turbines. The construction abroad of the two English Channel turbine steamers the past year, and their successful performance, and this action on the part of the Navy Department in this country, will both have a powerful influence tending to the introduction of turbines on ocean-going steamships of much larger size. In his report, submitted previous to his retirement from the active duties as Engineer-in-Chief of the U. S. Navy, Rear-Admiral Melville said:

"I respectfully recommend that one of the new vessels of the navy of not more than 5,000 tons displacement, and preferably of the scout or very fast cruiser class, be fitted with steam turbines instead of reciprocating engines. My reasons for this recommendation are that the steam turbine has now passed beyond the experimental stage, and various vessels in which it has been fitted, particularly fast passenger

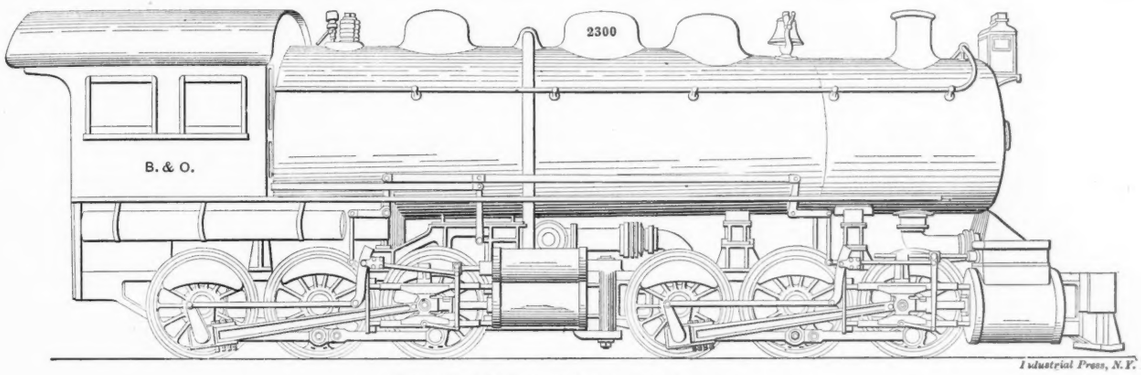
steamers, have proved eminently successful." He adds that the ability to use highly superheated steam, the few moving parts and the reduced engine room are in themselves sufficient reasons for extensive experiments with the steam turbine; and he favors the installation of such turbines in a small vessel, not because they may not prove efficient on a larger one, but because he believes that it is not a good policy to change the motive machinery in the larger ships until it has been shown by exhaustive trials on the smaller scout ships that it will be wise to make the change.

MALLET ARTICULATED TYPE LOCOMOTIVE FOR THE B. & O.

Railroad Gazette, September 4, 1903, p. 636.

An order has been placed with the American Locomotive Company by the Baltimore & Ohio R. R. for a very heavy freight locomotive of the Mallet articulated type that has been quite largely built for European railways. It is the intention to have this locomotive perform the work of two ordinary locomotives and to thus dispense with the aid of a pusher on heavy grades.

The Mallet compound is of the four-cylinder type. Usually all of its wheels are drivers, which are arranged in two groups. The rear group is carried by the main frame and is driven by the high-pressure cylinders. The forward group is carried by a supplemental frame and is driven by the low-pressure cylinders. The frame and wheels of the low-pressure engine form a truck on which the forward part of the locomotive is supported. The arrangement gives a locomotive a long total wheel-base but short rigid wheel-base. The total weight is available for adhesion. It is especially adapted to slow, heavy work on grades where sharp curves must be passed. The Walschaert valve gear is used.



Heavy Freight Locomotive for B. & O. R. R.

The building of this locomotive by the B. & O. is an experiment. Should it demonstrate its usefulness in the service for which it is designed, others will doubtless be built. The boiler will carry the unusual pressure of 235 pounds. The following dimensions, furnished by the B. & O., compare the Mallet type with the 1-7 class, which are the heaviest locomotives used on the road in regular freight service.

	Articulated.	1-7
General Dimensions.		
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Fuel	Bituminous coal.	Bituminous coal.
Weight in working order	285,000 lbs.	193,500 lbs.
Weight on drivers	285,000 lbs.	173,000 lbs.
Weight engine and tender in working order	415,000 lbs.	325,000 lbs.
Wheel base, driving	30 ft. 6 in.	16 ft. 6½ in.
Wheel base, rigid	10 ft. 0 in.	16 ft. 6½ in.
Wheel base, total	30 ft. 6 in.	24 ft. 9 in.
Wheel base, total, engine and tender	61 ft. 5 in.	57 ft. 7½ in.
Width of frame	5 in.	4 in.
Center to center		44 in.
Cylinders.		
Diameter of low-pressure cylinder	32 in.	
Diameter of high-pressure cylinder	20 in.	22 in.
Stroke of piston	32 in.	28 in.
Valves.		
Kind of valves	Balanced.	Balanced.
Type of gear	Walschaert.	Link.
Wheels.		
Number of driving wheels	12	8
Diameter of driving wheels outside of tires	56 in.	56 in.
Material of driving wheel centers	Cast steel.	Cast steel.
Thickness of tire	3 in.	3 in.
Driving box material	Cast steel.	Cast steel.
Diameter and length of driving journals	9 in. x 13 in.	9 in. x 13 in.

	Wagon top.	Belpaire wide fire-box.
Boiler.		
Style		
Working pressure	235 lbs.	205 lbs.
Inside diameter of first ring	76 in.	69½ in.
Horizontal seams	Sextuple riveted. Butt seam.	Double welt. Butt seam.
Circumferential seams	Double riveted.	Double riveted.
Fire-box length	105 in.	104⅞ in.
Fire-box width	77 in.	66 in.
Fire-box water space, front	5 in.	5 in. bot. 7 in. top.
Fire-box water space, sides	5 in.	5 in. bot. 6½ in. top.
Fire-box water space, back	5 in.	4 in. bot. 7 in. top.
Fire-box crown staying	Radial.	
Fire-box staybolts	Flexible and screw	Flexible.
Tubes, number	376	369
Tubes, diameter	2¼ in.	2 in.
Tubes, length over tube sheets	18 ft. 9 in.	13 ft. 9½ in.
Tubes, heating surface	4,135	2,662.92
Fire-box, heating surface	190	184.32
Total heating surface	4,325	2,847.24
Grate surface	56.1	48.06
Height of stack above rail	15 ft.	15 ft.
Ratios.		
Heating surface to grate surface	77.1	59.24
Heating surface to cylinder volume	.0068	.00216
Tractive power	63,800	39,688
Heating surface to tractive power	15.43	13.98
Tractive power to weight on drivers	4.46	4.31
Tender.		
Tender frame	Channel.	Steel.
Water capacity	7,000 gals.	7,000 gals.
Coal capacity	13 tons.	13 tons.

FRICTION BETWEEN WOOD AND IRON.

Engineering (London) August 21, 1903, p. 254. (Translation.)

The civil authorities in the Dortmund colliery district finding there was no accepted standard friction coefficients of wood on iron for the guidance of those having to design brakes for the winding drums used in mines, requested Professor L. Klein, of Hanover, to investigate the subject. In his experiments the test pulleys, which were mostly 15.75 inches diameter, were driven by a Pelton water wheel working under a constant head of 85 feet. The brake blocks were attached to a lever from the end of which weights were suspended. The machine having been gaged with the aid of straps, cords, and steel bands and spring balances, and very good curves having been obtained, experiments were made in three different ways. In the first set the load and speed were varied, but the pressure kept constant by altering the surface in contact, in accordance with the load. In the second set the pressure was increased, while the speed was kept constant. In the third set the speed and pressure were varied, the braking area being kept constant. This third method was finally applied because the experiments established that, within certain limits, the speed and pressure did not affect the friction coefficient. The limits were circumferential speeds from 3¼ feet to 65 feet, and pressure from 7 pounds to 142 pounds per square inch. Constant figures were generally arrived at after about half a minute.

As a rule the wood fiber was parallel to the pulley face, as in ordinary practice (*a*); sometimes the fiber was placed crossways to the pulley face (*b*); and end grain blocks were also tried (*c*); the letters indicate these conditions in the tables in which we summarize the results. Table I. concerns pulleys of cast iron or wrought iron finished smooth; *A* means that the pulley was carefully wiped, *B* that it was cleaned with benzine; *C* that the wood was soaked in oil. Table II. concerns wrought-iron pulleys not specially finished. In this case, as is well known, the rough points on the surface cause the brake-block

to oscillate; the braking effect is hence diminished and more uncertain, as the pulley has time to slip away under the block when it is not pressed on. Definite values, therefore, cannot be given. Beech and oak suffer more on rough pulleys than poplar, elm and willow, but are more efficient in braking power, probably because the charred particles fill up the rough

TABLE I. SMOOTH PULLEY FACES.

Material.	Beech	Oak.			Poplar.			Elm.	Willow.
	a.	a.	b.	c.	a.	b.	c.	a.	a.
Cast iron—A	0.28	0.29	0.25	0.19	0.34	0.30	0.29	0.32	0.43
	0.29	0.30	0.28	0.20	0.35	0.36	0.31	0.36	0.46
	0.30	0.31	0.35	0.21	0.37	0.40	0.37	0.38	0.48
B	0.36	0.30	0.35	..	0.39	..	..	0.36	0.41
	0.37	0.31	0.37	..	0.40	..	..	0.37	0.47
	0.38	0.32	0.40	..	0.41	..	..	0.39	0.50
Wrought iron —A	0.51	0.48	..	..	0.52	..	..	0.57	0.41
	0.54	0.51	..	..	0.65	..	..	0.60	0.63
	0.55	0.54	..	..	0.73	..	..	0.64	0.93
B	0.52	0.38	..	..	0.56	..	..	0.47	0.58
	0.54	0.40	..	..	0.60	..	..	0.49	0.60
	0.55	0.42	..	..	0.62	..	..	0.51	0.62
C	0.28	0.41	..	..	0.49	..	..	0.34	0.33
	0.35	0.50	..	..	0.63	..	..	0.40	0.38
	0.41	0.59	..	..	0.74	..	..	0.42	0.45

spots. Poplar proved to be the best brake-block material; it gives high friction and is little affected by oil. Willow is inferior, being sensitive to oil and giving diminished friction under heavy loads. Carefully finished and cleaned wrought iron is a better friction pulley material than rough wrought iron or cast iron.

TABLE II. ROUGH WROUGHT-IRON PULLEY—FIBER ALWAYS PARALLEL TO PULLEY FACE (a).

Material.	Beech.	Oak.	Poplar.	Elm.	Willow.
Pulley wiped	0.24	0.38	0.15	0.09	0.13
	0.39	0.47	0.18	0.14	0.14
	0.49	0.56	0.25	0.17	0.15
Pulley slightly oiled	0.16	0.12	0.17	0.14	0.15
	0.23	0.15	0.23	0.21	0.17
	0.34	0.28	0.35	0.29	0.21
Brake block soaked in oil	0.10	0.12	0.11	0.11	0.13
	0.12	0.13	0.11	0.12	0.15
	0.14	0.15	0.12	0.14	0.16

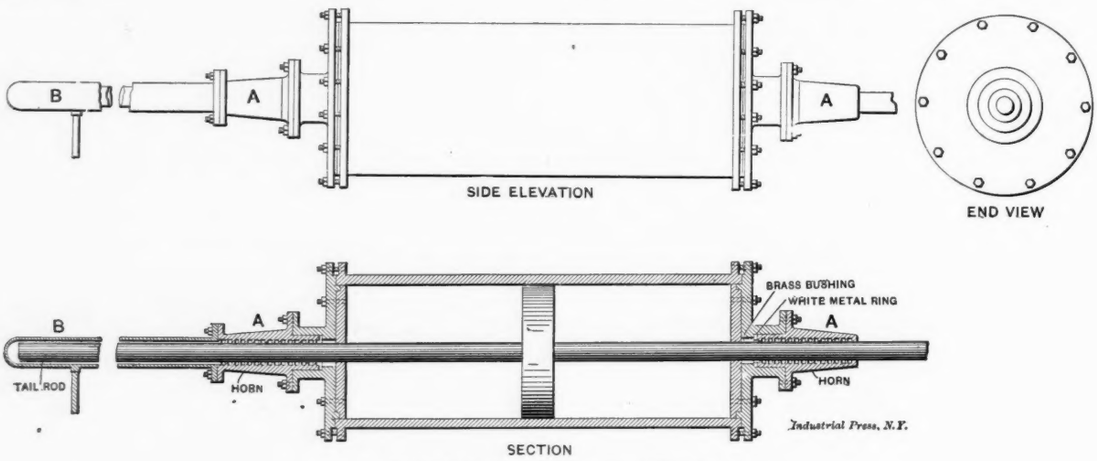
ENGINES AND PUMPS WITHOUT GLANDS.

Mechanical Engineer, England, August 29, 1903.

An interesting paper, read by Mr. Andrew Watson before the Mining Institute of Scotland on mine engines and pumps having no glands or soft packing for the piston rods, was published in the *Mechanical Engineer* of August 29, 1903. The principle employed is that of parallel grooves in the rod, or in the internal surface of a "horn," which takes the place of the ordinary gland. These grooves fill with condensation, making what is ordinarily known as "water-packing." The principle is one that has been used in this country to considerable extent in the construction of pressure regulators and similar apparatus that must work with a minimum of friction, but so far as we know it has never been used for the packing of steam engine piston rods, except in the case of tandem compound engines, between the high and low-pressure cylinders.

It appears from the paper referred to that mining engines have been in successful use in some of the Scottish collieries for 40 years, which have no glands, but instead have "horns," as shown at *A* in the figure. These horns are bored to fit the piston rods and are internally grooved, the grooves being parallel and about ¼ inch wide and deep. The grooves are cut at a distance of 1 inch apart the whole length of the horn and at the inner end a ring of white metal, bored out to fit the piston and "saw cut" is fitted. This ring has a thickness of about ⅜ inch and a breadth of 1⅛ inch. The first engine fitted in this way had the horn cast upon the cylinder cover, and bored out, as before described. As a precaution a stuffing box was placed upon the end of the horn of the first engine so made, but no packing was used. This engine was in use for a period of 15 years, after which it was sold, and all trace of it has been lost.

The three coupled winding engines at Cadzow Colliery, with cylinders 24 inches diam. and 5 feet stroke, working at a pressure of 80 pounds per square inch, have been altered by simply fitting the horn upon the stuffing boxes, as before described. The horns might be made longer than they are at present, but they work most satisfactorily, and allow no steam to pass out. An iron casing, *B*, with an inside diameter ⅝ inch greater than that of piston rod, is fixed to the outer flange of the horn, enclosing the piston rod, and into the



Piston Rod with Packing without Glands.

space between the casing and the rod a small quantity of exhaust steam is allowed to pass. This maintains the piston rod at a temperature of about 212 deg. F. If large slow pumping engines were so fitted it is certain that a considerable saving in steam would ensue, as the loss caused by using cold piston rods must be great.

At Cadzow Colliery, working under full load, it has been found that since the horns have been fitted to the winding engines, full steam is admitted for 8½ revolutions per minute, whereas, when ordinary packing was in use, steam was admitted for 9½ revolutions. It should, however, be noted that before the horns were fitted the piston rods were not in good condition. Experiments made with one of the pistons of these winding engines showed that when disconnected from the cross-head and in a position ready for work, the piston and rod, weighing fully 1,000 pounds, could be easily pulled by one man along the cylinder. A Salter spring balance was fixed to the outer end of the piston rod and registered 100 pounds—the power necessary to start and move the piston and piston rod. If a marking of white lead be put on the rod it remains on it for hours. These horns have been in use at Cadzow Colliery for six years, and the repair and upkeep of the same are practically nil.

The advantages of having engines fitted with these castings or horns are as follows: 1. There is a minimum of friction

and consequent saving in the consumption of steam. 2. The piston rods last very much longer, owing to the diminished friction and wear. 3. The rods carry the piston, so that the piston may be said to float, and does not rest on the bottom of the cylinder. 4. There is a saving in packing and labor, and it is no longer necessary to stop the engine at possibly inconvenient times in order to pack the stuffing boxes.

PICKLING CASTINGS.

Railroad Herald, August, 1903, p. 13.

There are two general methods of treating castings, which are to be machined, to remove hard scale, viz.: the sand-blast and the acid bath. Iron castings are usually pickled with sulphuric acid or hydrofluoric acid, the former being most commonly used. The sulphuric acid pickling solution is usually made up of one part of sulphuric acid to ten parts of water. The sulphuric acid should always be poured into the water while the latter is being stirred. The reason for this is that a chemical reaction takes place which causes the bath to become quite warm, but there is no dangerous ebullition if properly mixed. But if the water is poured upon the sulphuric acid, the latter, being much heavier than water, remains at the bottom. When an attempt is made to stir the solution, the water enters the acid in small streams, and is instantly raised to the boiling point, generating steam, which may cause an explosion. Such an accident would be likely to throw the concentrated acid over the workman and result in serious burns.

Sulphuric acid will not attack the sand or black oxide of iron which form the scale upon castings, but the sand and scale are porous and the acid soaks through and attacks the iron under the scale. It finally dissolves a sufficient amount of iron under the scale to loosen the latter. When the workman sees that the scale is all loose the castings should be removed and washed, preferably with hot water. If the castings are small it is a good practice, after washing, to immerse them in a soda solution for a short time in order to thoroughly neutralize any acid.

One great objection to the use of sulphuric acid as a pickling solution is that if there are any soft or spongy spots in the iron, the acid will penetrate these, and it would be practically impossible to wash it out or neutralize it in the soda bath. Any acid thus entrapped in the castings will continue to eat until it is changed to sulphate of iron or green vitriol. This will tend to make the spongy or soft spots in the iron still worse and may weaken the castings to a large extent. If the acid has been used a number of times a large portion of it is converted into green vitriol, and hence the solution will not attack the iron. In this case it is necessary to add more acid to the bath or else to throw away the old bath and make up a new one.

While the workmen may receive quite serious burns from sulphuric acid it is not nearly as dangerous as hydrofluoric acid. The thin hydrofluoric acid will penetrate the skin and attack the flesh and bones underneath and may result in very serious injuries. It will also attack the finger nails very readily, but if used with care it makes a pickling solution which has a number of advantages over sulphuric acid.

Hydrofluoric acid is commonly sold in three grades. The first contains 30 per cent. of acid, the second 48 per cent., and the third 52 per cent., the balance of the solution being water. The 30 per cent. solution is that usually employed for pickling castings. One gallon of the 30 per cent. solution should be used to twenty to twenty-five gallons of water. If it is desired to pickle more rapidly less water may be used, and if it is desired to get more use of the acid—that is, make it do more work—slightly more water may be used. Hydrofluoric acid does not act upon the iron to an appreciable extent, but attacks the sand and dissolves it. It also dissolves the black oxide of iron.

When castings are pickled in sulphuric acid the surface is left with a dull or black appearance. When pickled in hydrofluoric acid the surface has a much whiter and often almost silvery appearance. The surface of castings pickled with hydrofluoric acid is also very much smoother than those pickled with sulphuric acid. For this reason hydrofluoric acid pickling is used in almost all cases in which the parts are to be polished or nickel-plated, and sulphuric acid pickling only in cases where it is desired to remove the scale so as to facilitate the machining of the castings.

When pickling with hydrofluoric acid the small casting may be put into the bath and the larger ones may have the acid poured over them just as if working with sulphuric acid. The hydrofluoric acid bath is always used cold, but should be kept above the freezing point. The bath can be used repeatedly by adding about one-third the original quantity of acid before introducing a new lot of castings. If it is desired to keep the surface of the castings bright after they are pickled in hydrofluoric acid they should be washed with hot water immediately after coming out of the acid and should be left in the water until they are heated through. If this is done when the castings are taken out of the water they will dry quickly from the heat which they have absorbed from the water. If the castings are washed in cold water they will remain wet for some time and hence will rust. A little lime is frequently added to the washing water which is used after hydrofluoric acid pickling.

When handling concentrated hydrofluoric acid the workman should always use rubber gloves. If any acid is dropped or splashed on the skin it should be washed off at once with water and dilute ammonia and this will usually prevent any injury. The dilute hydrofluoric acid of the pickle bath will not attack the skin instantly, but the workman should never put his hands into this solution, as it will attack the hands to some extent and will result in serious sores if he persists in handling the castings when wet with the pickling solution. The dilute sulphuric acid pickling solution will not injure the hands if it is spilled upon them; in fact, its only effect is to make the skin coarse and rough.

For pickling brass castings a solution is frequently made up by mixing three parts of sulphuric acid and two parts of nitric acid and adding to each quart of the mixture about a handful of common table salt. This mixture is frequently used undiluted with water and is to be handled with great care, as it will attack the hands badly. One advantage of this solution is that it leaves a good color on the castings, and hence it is frequently used for this purpose.

The pickling solution used for brass castings must be kept in an earthenware crock or in a vitrified bath tub, and the bath must be large enough to dip the large castings into it. Owing to the fact that hydrofluoric acid will attack sand it cannot be kept in a crock or jug, as it would immediately eat a hole through it and escape. Hydrofluoric acid must be kept in a lead carboy, but the dilute acid can be kept in wooden tubs or barrels. Either dilute or concentrated hydrofluoric acid will dissolve glass very readily, and hence cannot be kept in a glass bottle. Concentrated sulphuric acid is frequently kept in iron tanks, but dilute sulphuric acid attacks iron readily, and hence it is necessary to keep dilute sulphuric acid in earthenware jugs and jars, glass bottles or wooden tubs or vats.

NOVEL JACKETED ENGINE.

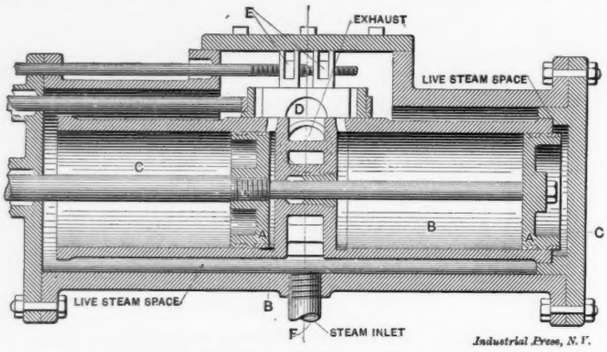
Power, September, 1903, p. 486.

The steam engine, a longitudinal section of the cylinder of which is shown on next page, was designed by Mr. J. C. Lemon for Mr. Louis Hicks, Cincinnati, O., to reduce cylinder condensation. There are two working cylinders, with a piston in each fixed to a common piston rod, and the two working cylinders are enclosed in an outside cylinder so as to form a steam space entirely around the inside cylinders, thus completely jacketing the cylinder heads, walls and pistons. In addition to this jacketing, the live steam following the pistons in the open ends of the cylinders washes the cylinder walls, and the effect of the whole arrangement is, to a great extent, to supply heat to the admission surfaces.

The valve is a slide valve with cut-off blocks on top, so as to obtain a wide range of cut-off. A trap was attached to the outside cylinder, into which the water condensed in the outside cylinder and open ends of the inside cylinder was drained. It will be observed that each working cylinder is single acting,

the combined effect of the two giving the cycle of the common engine. Dimensions follow.

Diameter of cylinder, inches	6.125
Diameter of piston rod, inches	1.0
Stroke of piston, inches	10.0
Displacement of each piston, cubic inches	286.8
Horse-power for one revolution and one pound mean effective pressure	.000724
Clearance in head end, per cent	4.8
Clearance in crank end, per cent	4.2



Steam Jacketed Engine Cylinder of Novel Design.

The tests show the following interesting results:

First—The lowest steam consumption of record, so far as the designer knows, for so small an engine.

Second—That the steam consumption is lowest when the expansion is the greatest, while in the ordinary engine the best result is obtained at about four or five expansions.

Third—That steam of high pressure (130 pounds gage) is expanded in this engine to atmosphere at exhaust with the minimum loss, thus accomplishing the same result in a simple engine that is obtained by multiple-cylinder engines.

DATA OBTAINED BY TESTS.

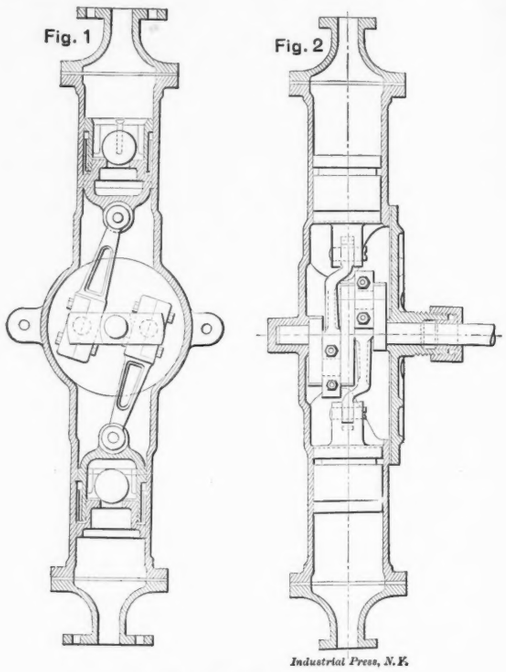
	1	2	3	4
1. Number of test				
2. Cut-off, per cent. of stroke	5.5	9.9	23.4	34.
3. Steam pressure pounds by gage	131.	131.4	132.	133.
4. Average revolutions per minute	89.4	90.8	92.6	90.4
5. Duration of test, minutes	60.	60.	60.	60.
6. Condensed steam from cylinders	59.36	98.25	224.	297.8
7. Total heat in one pound of dry steam at average pressure of test	1190.5	1190.6	1190.7	1190.9
8. Heat in one pound of water at temperature of exhaust	180.	180.	180.	180.
9. B. T. U. absorbed by engine for each pound of steam delivered from cylinder	1010.5	1010.6	1010.7	1010.9
10. Condensed steam from trap	12.25	18.43	18.30	12.20
11. Total heat in one pound of steam used in trap	1190.5	1190.6	1190.7	1190.9
12. Heat in one pound of water at temperature of trap	327.5	327.6	328.0	328.5
13. B. T. U. absorbed by engine for each pound of steam condensed in trap	863.	863.	862.7	862.4
14. Weight of condensed steam from trap reduced to the same basis as that delivered from cylinder Item 13 ÷ Item 9 × Item 10	10.46	15.74	15.62	10.30
15. Total equivalent weight of steam delivered from cylinders	69.82	113.90	239.62	308.1
16. Average M. E. P.	22.48	35.80	60.65	77.73
17. Horse power of engine	2.91	4.71	8.13	10.17
18. B. T. U. per horse power per minute	403.	407.	408.	510.
19. Pounds of steam per I. H. P. per hour	23.99	24.20	29.57	30.30

DOUBLE-ACTING PUMP.

Le Genie Civil.

An interesting double-acting pump was recently exhibited at the Cardiff Exposition of the Royal Agricultural Society by Messrs. W. H. Wilcox & Co., of London. It is here shown in section in Figs. 1 and 2, from which it will be seen that the construction is very simple. It has two pistons which are made to move in opposite directions. Each piston is attached to a crank and carries a spherical valve. When the pistons are moving away from each other a partial vacuum is produced between them and the liquid rises into the body of the pump. On the return stroke the space between the pistons is contracted and a portion of the liquid is forced through the upper valve into the delivery pipe. There is no foot valve, that in the lower piston taking its place. These spherical valves are of rubber and the pistons are packed with leather. In the operation it is a matter of no moment whether the shaft makes a complete revolution or not and it can be moved by power or by hand.

G. L. F.



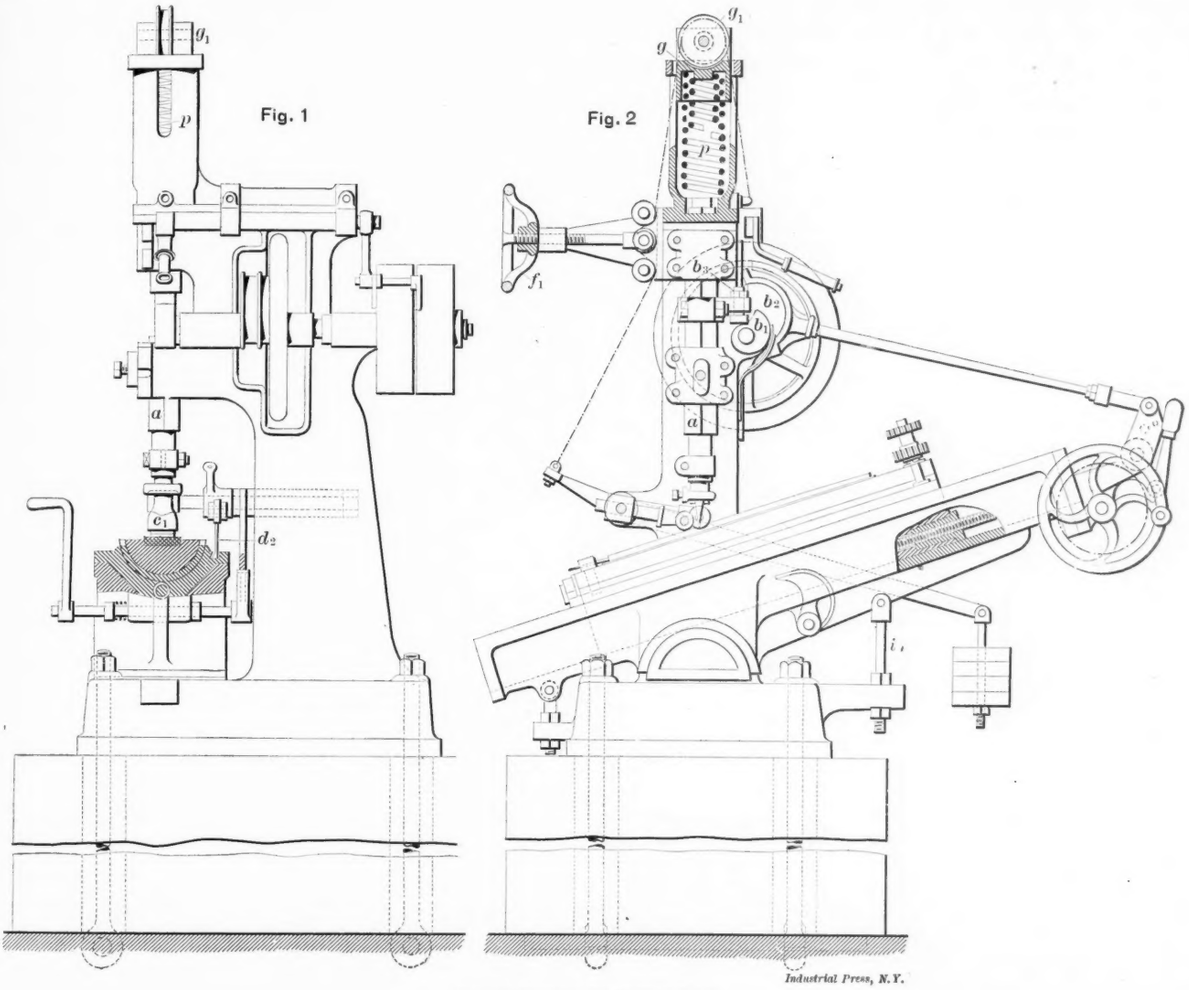
Pump without Cylinder Heads.

CARBORUNDUM AS A FURNACE LINING.

Electrical Review, August 28, 1903, p. 351.

Further details as to the employment and value of carborundum as a furnace lining, and as a means of preserving less refractory materials against fire or high temperatures, to which brief reference was made in the issue of December 12, 1902 (see MACHINERY for February, 1903), have been given in a recent article printed in the German *Zeitschrift fur Beleuchtungswesen.* When any object such as a crucible, retort, or furnace is to be treated, the carborundum powder is mixed with one-third its weight of water-glass, and the whole diluted with water until it forms a cream suitable for application with a stiff brush. If, however, the carborundum is likely to come into contact with basic substances, either basic bricks or basic slags, the water-glass is replaced by fireclay, using 85 parts of carborundum to 15 of the clay. It is then laid on the surface which is to be protected just as if it were an oil paint, and in such quantity that it forms a layer about 1-50-inch thick. To produce a film of the thickness quoted requires about 3½ ounces of carborundum per square yard. Brickwork must be thoroughly air-dried before the coating is put on; mortar especially must be as dry as possible, or, on heating, evolution of steam may blow the coating off. Massive structures of brickwork are best heated gently for some time and then permitted to become cool before the "paint" is applied. When the painted surface has been allowed to dry for 24 hours, it is ready for use; but it should be warmed slowly the first time. Gradually the water-glass disappears, and the carborundum remains as a kind of glaze, which is perfectly smooth, does not form a slag with the ash of any fuel, withstands rapid heating and cooling, and does not chip off. The process is available for any furnace or apparatus used in connection with gas or solid fuel firing. At the Düsseldorf Exhibition, a tube-welding furnace was shown, which had been given a 1-50-inch coating of carborundum

and water-glass. This furnace was worked for 10 hours a day for 6 months, and at the end of that period was in as good condition as at first, no repairs having been called for. A mixture of equal parts of carborundum and fireclay can also be employed to stop any cracks in coal gas retorts, being capable of application while the retorts are still hot. In one experiment two leaky retorts were mended in 3 minutes, and they afterwards lasted for 3 months. If the retorts are to be repaired cold, the usual mixture of carborundum with water-glass should be used, but in other cases that with fireclay is preferable. Porcelain crucibles are, with advantage, coated inside and out with the same protective layer; this makes them last longer than usual, and enables them to bear rapid and frequent changes of temperature. Crucibles for the manufacture of steel are better painted on the outside only.



Special Machine for Cutting Files.

FILE-CUTTING MACHINE.

Der praktische Maschinen-Konstrukteur, July 16, 1903, p. 120.

The machine consists of a light frame anchored to its foundation by four bolts; a table which can be moved along its support as shown in Figs. 1 and 2 and which may be set at any delivered cutting angle by the adjusting screw *i*. The hammer *a* is carefully fitted and is always held in its closed position. The blow is dealt by means of the back spring *p* the strength of which is regulated according to the size of file being cut; a light spring being used for small and a heavy for large files. The actual strength of the blow delivered can be regulated according to the size of the spring by the handwheel f_1. The pressure chain, which may be tightened by the handwheel, passes up and over the roller g_1, against which the spring cap *g* has a bearing, and thence down to the frame of the machine where it is fastened. The automatic regulation of the blow, which is always proportioned to the file being made, is effected by the crank arm d_2. By means of an arrangement, not shown in the drawings here reproduced, a foot treadle can be used to easily and quickly regulate the blow to any degree of intensity. This is of special importance in the cutting of three-cornered files where the blow must be comparatively light at the point, and heavier at the middle and tang. In order to obtain a fine tooth at the point, there is an arrangement whereby the pressure is automatically relaxed as the chisel approaches the point of the file. The operating mechanism is shown in Figs. 1 and 2, in which the checknut b_3 is loosened and the chisel c_1 is brought down against the thinnest part of the file to be cut. Then this checknut is run down towards the tappet b_1, and so held that there will be a play of from .2 to .6 inch according to the type and size of file to be cut.

Power is applied through a tight and loose pulley shown at the side of Fig. 1, and operates upon the lift of the hammer through the cam shown at the side of the same illustration. The feed of the table with the file is effected by means of an eccentric b_2 with a ratchet connection to the mechanism shown at the right of Fig. 2. G. L. F.

ERICSSON, THE MAN.

Egbert P. Watson, in the Iron Age, August 13, p. 12.

The dedication of a new statue to the memory of John Ericsson at Battery Park, New York City, the first of August, led Mr. Egbert P. Watson to contribute some brief reminiscences of the great engineer in a short article in the *Iron Age*. Mr. Watson knew Ericsson for twenty-five years and as a machinist at the old Novelty Iron Works, New York, worked on the *Monitor*, and in fact, drove the first bolt in her turret. Later he held an editorial position on a technical paper and took occasion to comment favorably on the *Monitor*, before it had gone into commission. The vessel had many enemies in high positions so that Ericsson was grateful to anyone who stood up for her. Mr. Watson had not met Ericsson up to that

time and consequently was greatly surprised to receive a note, asking him to call. Now this was a very unusual thing; the country was in the throes of civil war, and every one was at the highest tension, Ericsson especially, for his reputation and fortunes were staked upon what might happen within a very few hours. That he should be capable of unbending for an interview with a total stranger, when he refused to see officials of high standing in the army and navy was remarkable, to say the least. The appointment was kept and a very brief one it was, merely rushing in and rushing out of the room upon Captain Ericsson's part, with a cordial grasp of the hand and a few words to express his obligations for the article, and Watson found himself upon the doorstep, being literally thrust out by Ericsson with a "Good morning, sir, I am busy."

Mr. Watson further relates:

Thereafter I had occasion to call, by his invitation, many times, and saw him under all conditions of life, once when an attempt to blackmail him had been made by a fatuous reporter of a daily paper. To say that he was angry is a very mild expression; he was simply furious. The reporter had an article with him written by some one on the staff which he said Captain Ericsson might like to see before it was published; it raked the *Monitor* system fore and aft as a mere job to get the people's money. Ericsson read the article and then asked the reporter what it would cost to suppress it—to trap him. The reply was:

"One thousand dollars."

"Go and publish it, you infernal scoundrel; I do not care what you publish. I live for the truth, but you are an infernal liar; I will not have such a man in my house another moment; get out!"

I saw him just after this incident and he was still fuming from it.

This narrative, to be truthful, should record that this was frequently his mood, and he had much to make him so.

Ericsson was by nature a most forceful man, combative and assertive to a marked degree; he was not diplomatic or reticent about anything; if he had an opinion he gave it in old fashioned Anglo-Saxon terms that left no doubt of what it was. Once when I supposed I had invented a desirable form of screw propeller he looked it over carefully, and then said: "It is not worth a damn." On another occasion, however, when I showed him a working model of a lever engine, a type he particularly approved of, he said it was excellent, very good indeed, and he would like to see it in action. He asked how fast the model had run (it was 4 feet long and 8 inches beam), and when I replied at the rate of three miles an hour for a short distance, he said: "My, my! You have done a great thing; I never could make a model go faster than one and a half miles an hour."

These incidents are not related because I happened to be an actor in them, but for the reason that they show Ericsson to have been fair-minded and not incapable of seeing value in the ideas of others, although this view is taken by many at this day, upon very slight evidence.

It is not generally known that for his *Monitor* plans Ericsson never received one penny from the government in any form, and all bills introduced in Congress to compensate him were killed by his enemies. It was the same with the United States steam vessel *Princeton*, which was the first screw steam vessel of war owned by the navy, and the pioneer in naval screw steamers, although the English naval steam vessel *Ranger* was built shortly after. Through the influence of naval officers of the period Ericsson was never rewarded for her plans and engines, which were a distinct innovation at that time. These things had their influence in a marked degree, and while he was a man who would not submit to an injustice if he could help it, in these instances he was powerless. Another incident which happened long after the civil war came about through the neglect of the managers of the Centennial Exposition, in 1876, to invite Captain Ericsson to contribute a history of his inventions. He was greatly chagrined, but this could be remedied, and he set about it. It took the form of a large volume containing his principal engines and devices of every kind from the beginning of his career. It was profusely illustrated with costly engravings and printed on plate paper made expressly for it. The edges were gilded with pure gold, or 18 carat, at least, and bound in the best turkey morocco. This book cost $60 a volume or $60,000 for an edition of 1,000 copies for complimentary distribution; none of them was ever sold by Ericsson. It was doubtless the most costly work ever gotten out in this country.

Although Ericsson was not a wealthy man he was very lavish in his expenditures and his right hand never knew what his left had given away. At one time he was having a large, intricate casting for a surface condenser made at the Morgan Iron Works, New York. The casting had been poured and the foreman of the foundry wanted to leave it in the sand to cool; but Ericsson was anxious to see it and ordered it dug out. It looked all right and after a little badinage with the foreman about his timidity Ericsson went away. The next day, however, told a different tale—the shrinkage had torn the casting in two and the foreman awaited his visit with anxiety. When he came and saw what happened he merely said: "Can you make another with what you know now?" "Yes, sir," said the foreman. "Go ahead then," said Ericsson. That condenser casting cost $1,500 and the loss fell upon Ericsson.

In appearance Ericsson was of middle height, but he had immense shoulders and chest, and must have possessed great strength; his countenance was stern and forbidding, but when pleased he could lighten up, and in that mood was a handsome man. During the last thirty years of his life he lived in what was once a popular residence section of New York, but had finally become a cheap boarding-house section, inhabited by many Italians and with a "flavor of mild decay" over all. He disliked change so much, however, that he could not be induced to move to other quarters.

The models of all his inventions were displayed in glass cases around the room, and they were beautifully made. Every detail was constructed upon a certain scale and woe be to the model-maker if he departed in the least from the drawing. Ericsson was a fine draftsman and declared that all dimensions were on his drawings and that the machine would go together if the drawings were followed. At 84 years of age he sent his secretary with some drawings to show me that his hand had not yet lost its cunning. They were surprisingly clear for a man of his years. Late in life he shunned all association with every one. He had become very deaf and was sensitive to his infirmity, but he did not forget anyone who had ever had his regard and confidence.

* * *

TRAIN RESISTANCE AT HIGH SPEEDS.

The signification of T_1 was accidentally omitted from the note "Train Resistance at High Speeds," which appeared in the *Engineering Review* section of the September number. Therefore the formula is repeated in the following, with the signification of all the symbols employed:

$$S = \frac{4 + 0.13\ V + 0.004\ A\ V^2\ [1 + 0.1\ (n - 1)\ ]}{T_1}$$

where

S = the train resistance in horse power per ton;

V = the speed in miles per hour;

A = the cross sectional area of the car in square feet;

T_1 = weight of train in tons;

n = the number of cars in the train inclusive of the locomotive.

* * *

According to experiments made in Germany the danger of firemen receiving a fatal shock when playing a hose onto a charged electrical conductor, is not nearly so great as has been popularly believed. First, it has been shown that the resistance of the human body from the hand to the earth when standing on wet ground, is not less than 15,000 ohms, and that a current of 0.03 ampere is not fatal under ordinary circumstances, although dangerous. A stream of water was directed by a nozzle onto a bare wire having a cross-section of 0.145 square inch and carrying a three-phase current of 6,000 volts. With the end of the nozzle only 12 inches from the bare wire, the tests demonstrated that it was not possible to receive a fatal shock when pure water passed through the hose. But with the water containing 0.5 per cent. of soda, the distance must be increased to nearly 40 inches before there is no danger of fatal shock. On a 550-volt direct circuit with the nozzle directed onto the wire at a distance of less than 1¼ inches from it, the actual current transmitted through pure water was only 0.016 ampere, or slightly more than one-half the limiting value.

A READING ROOM FOR EMPLOYES.

L. G. STEBBINS.

One of the greatest, if not the very greatest, influences upon a man's thought and consequently his conduct is in the matter of his intellectual food, that is to say, what he reads. Everybody who can read, does read, and the tremendous influence of what they read upon their minds and characters cannot be estimated. The public press claims to, and certainly does influence public opinion to a great extent. How is this possible? For the reason that the public reads and the public's opinions and conclusions are formed from what they read concerning a given subject. Almost everybody reads the daily papers, and all, with a mind of average activity, form opinions and arrive at conclusions based upon what they have read about a certain subject. In these days when the workingmen are coming more and more to think for themselves, it is of the utmost importance that their line of thought be in the right channels and their meditations along lines which make for the peace and well-being of the community to which they belong. The best way to secure a pretty evenly-balanced mind is to read only what is moderate, fair-minded and correctly stated, without prejudice or jealousy or anything that tends to warp a man's mental vision. It may be true that some men are born with a taste for the vicious, and such men will of course, be the hardest to deal with, but the great majority of men have minds of good caliber, capable of good mental balance, provided they are developed by proper influences and proper food.

Every employer has it in his power to do something in this work of education, and the results in the long run certainly justify the slight expense he may undergo in his effort to help along a good cause. He can provide some good literature for the men in his employ to read, and he can furnish them a good, light room to read it in, and he can encourage them to spend some of their spare time in the reading room connected with the shop. The plan is entirely feasible, and will work out for the good of both men and employer. Let the employer select a good, clean, light room—in the office building if possible—and furnish it with chairs, long tables, book shelves, paper files, etc. Everything should be selected with a view to comfort and durability, and should not be the cheapest that can be bought. Let the men feel as though the place was theirs to be enjoyed, and they will be a rather unusual set of men if they do not proceed to enjoy it. In the selection of the reading matter the employer should use his best judgment and should have a good assortment at all times so that interest in the enterprise will not wane on the part of the men. Let two or three copies of each of the best local papers be provided, and also two or three of the leading papers of the section of the country where the plant is located, taking care to exclude the sensational and flashy "yellow sheets" which are working untold mischief among the workingmen of our country to-day. Good magazines (the best are not too good) should be accessible, both trade publications and other magazines covering the general field of literature. In addition to this there may be some good books, novels, history, and technical works bearing upon the various phases of the work the men are engaged in. Above all things steer clear of political questions and do not select the reading matter with a view of proselyting the men to your convictions as regards the question of which is the best party. Exclude the rabid paper whether it be of your own party or another.

The expense of providing reading matter for a reading room that would be a credit to the shop ought not to be over $2 per week at the outside, and I really do not know how $2 per week could be spent to better advantage. There will be a good many magazines received gratis from publishers which can go into the reading room, and gifts of books will be forthcoming when the public spirited men of the town learn of what is going on in such and such a shop. The room should be open to all employes, of course, and most of them will drop in, perhaps out of curiosity at first, but later they will have formed the habit of depending upon the reading room for information of various kinds, and by reading and comparing the views of daily papers that are acknowledged to be solid and respectable, with the "yellow sheets" which some of them have been accustomed to read, will be led to drop the sensational paper, and take up the other one. This thing has happened, and would happen often if the comparison between the two classes of papers were brought to their attention daily for a while. The reading room should be open during the noon hour so that the men who carry their dinners may profit thereby, and for two or three hours during the evening. There are generally some men in the shop with natures inclined to be studious, and a man of this character can usually be found who will act as librarian and have charge of the reading room under the head of the firm. Such a man will take interest in the scheme, and will do much towards making the enterprise a success.

It is true that almost every town of any size has a free public library and some will say that there is no necessity for a reading room or library, if you choose to call it such, connected with a shop. The fact is that while there are libraries the workingmen are conspicuous by their absence from the reading rooms of the public institutions. They and their families may draw books from the library, but they are not found in the reading room, poring over the latest and best in science, history or fiction. The best thing about the shop reading room is that it fosters the spirit of fraternal feeling that exists between shopmates, and the men can come to the room without feeling ill at ease because they do not look as well as some one else. They can drop in at the room after supper and mingle with friends, reading good newspapers, and some of them perhaps studying to be better workmen. Occasionally a short, practical talk on some of the burning questions of the day may be given—another means of educating men and training their minds to run in the right channel. Men form opinions from hearing other people talk, and next to reading this is undoubtedly the most important factor in a man's education. In every town there will be found public spirited men, of good character, wisdom and moderate in their expressions, who will be glad to address a gathering of men, realizing as they do that the peace, prosperity and well-being of the community depend on the conduct of the workingmen of the place. A well read, educated man is the best man in the world to have for a neighbor, be he a millionaire or a workingman, and every man who employs ought to be glad to have an opportunity to assist in educating his men so that they will be a credit to him and the town where they belong.

From a purely selfish standpoint—that of returns on the money invested—the enterprise will certainly prove its value after a fair trial. Educated men make good workmen, and good workmen turn out good work, and good work gets good customers, etc., and so on. But a man, be he employer or not, should not worship the money god too fervently, else his efforts may come to naught after all. There is certainly something higher in this world to live for than mere money getting, and happy is the man who learns this early in life and shapes his course accordingly.

The scheme I have outlined is not Utopian to a very great extent, and the whole plan is practical and entirely feasible. Many manufacturers have already instituted reading rooms of this kind and we think they are more than satisfied with the results. It is a movement in the right direction, and a step forward in the march of progress. It will be a great help in the solving of the great question of the day—the labor question—as a man who has absorbed all the good things that have been written in regard to the brotherhood of man, and the relation of labor to capital, views of moderate and fair-minded men both employers and employes, is pretty sure to try and deal fairly when a question comes up for settlement between himself and his employer.

* * *

Out of 16 tests of boiler joints, with nickel steel rivets, made by the Bethlehem Steel Co., the plate failed in two and the rivets in six, when in single shear; and when in double shear, the plate failed in six tests and the rivets in two. In single shear the ultimate shearing strength of the rivets was 45,000 pounds, and when in double shear 88,000 pounds. It was deduced that a ¾-inch nickel steel rivet could safely replace a 1 1-16-inch or even a 1⅛-inch steel rivet.

AN INTERESTING ROPE TRANSMISSION PROBLEM.

The situations and requirements of rope drives are such that it is very seldom that any two installations will be alike, and the engineer in designing a new drive is obliged to refer in almost every case to the fundamental principles governing such drives, rather than to the precedent of former experience.

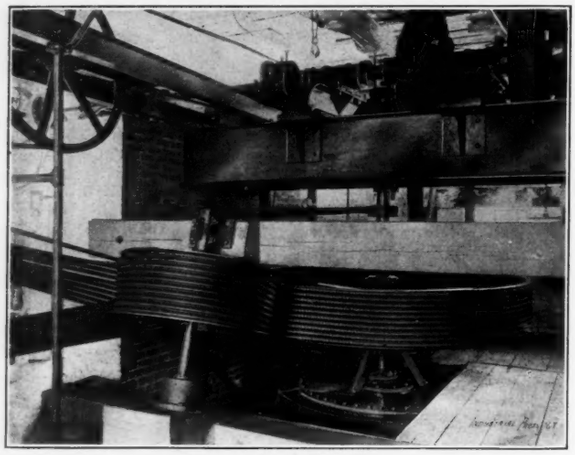


Fig. 1. Showing Wheel Casing and Idler.

An unusual problem was presented in the installation of a rope drive for Messrs. James & E. H. Wilson, operating a large woolen mill at Pittsfield, Mass. The mill was formerly operated by steam power. An excellent water power, however, is located about three-quarters of a mile from the woolen mill, in a building formerly vacant, and which would probably have been abandoned were it not for the water power. Messrs. Wilson purchased the abandoned mill with the idea of using the water power for generating electricity, the electricity to be transmitted for driving their woolen mill, thus taking advantage of the economy of the water power over their steam plant.

The ordinary method of transmitting power from a turbine shaft by means of gears was found impracticable and the only economical method that seemed to be available was by means of manila rope transmission. The shape and dimensions of the wheel house, however, were such that 16 feet was the greatest available distance between the vertical water wheel shaft and the dynamo. The power to be transmitted was 200

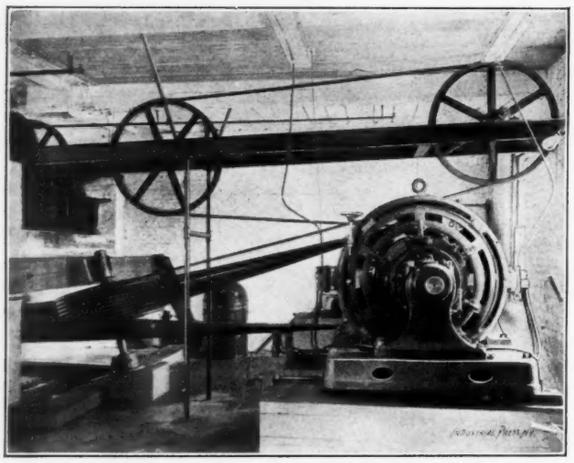


Fig. 2 Generator, with Tension Carriage Overhead.

horse power, and it is quite evident that these centers were exceedingly short for a rope transmission, especially as on account of the vertical turbine shaft and the horizontal dynamo shaft the drive must be a quarter twist.

The plant was designed and installed by H. W. Caldwell & Son Company, of Chicago, Ill., through the engineers in charge of their eastern sales and engineering office at 95 Liberty Street, New York City. So far as the designers are aware, this is the shortest quarter twist drive in use where a considerable amount of horse power is transmitted and a number of ropes are employed.

The illustrations shown will make the arrangement of the drive plain. Fig. 1 shows the water wheel case and the vertical shaft supported at its upper end by a heavy steel construction. The heavy support necessary for the gear drive is some indication of the comparative ease of operation of the modern rope transmission as compared with the old gear drive. In Fig. 1 is also shown the deflecting idler carrying the slack ropes, which, as will be noticed, is placed very close to the driving sheave. A portion of the tension carriage is also shown overhead.

In Fig. 2 can be seen a portion of the driving sheave at the left of the cut. The photograph of Fig. 1 was taken from a position in front of the window shown in Fig. 2. The position of the generator with reference to the driving sheave is clearly shown in Fig. 2; the receiving sheave being on the other side of the generator. The lower ropes are the pulling ropes and the slack is taken to the tension carriage from the driving sheave over the upper groove of the deflecting idler. The one-groove re-winding idler is placed above the generator; from thence the rope passes over the tension carriage sheave and returns to the driven sheave on the generator.

Particular attention is called to the quarter twist arrangement of the ropes, another view of which is shown in Fig. 3.

In installing the drive the driving and driven sheaves were

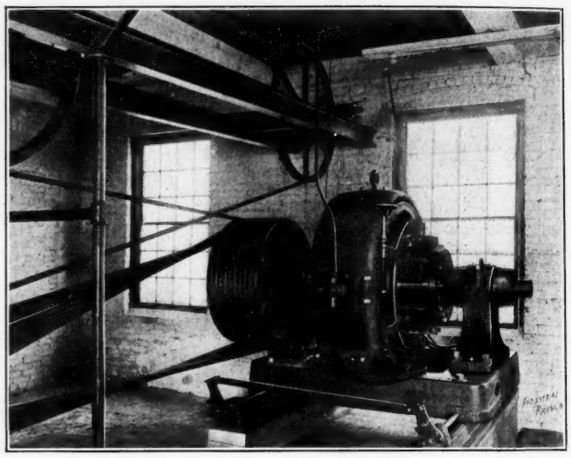


Fig. 3. Generator, showing Receiving Sheave.

placed according to the usual rules for setting quarter twist belts or ropes. The 10-groove deflecting idler was placed as nearly theoretically correct as could be, and the tension carriage and the re-winding idler were placed in position. The rope was then wound, and by raising the generator slightly the catenary of the ropes between the driving and driven sheaves was taken into account, so that the ropes would lead correctly between the two sheaves.

The speed of the ropes is about 5,000 feet per minute, and notwithstanding the short centers, high speed, and the many reverse turns, the drive has given excellent satisfaction since its installation. A recent report from Messrs. Wilson is to the effect that the drive is working very satisfactorily—this report coming about a year after the installation of the transmission.

The driving sheave on the water wheel shaft is 96 inches diameter, running 209 revolutions per minute. The driven sheave on the generator is 34 inches diameter, running 585 revolutions per minute. Both sheaves are grooved for ten 1⅛-inch ropes. The distance between the deflecting idler sheaves and the driven sheave is approximately ten feet.

The engineers of H. W. Caldwell & Son Company having this installation in charge feel that the successful solution of the problem is an instructive precedent for the use of rope drives in situations heretofore considered too difficult for this class of power transmission.

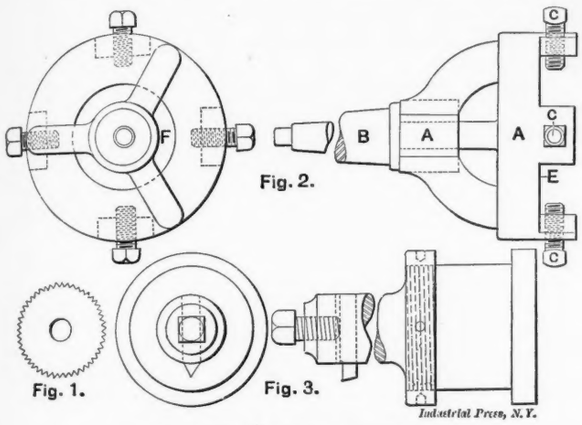
LETTERS UPON PRACTICAL SUBJECTS.

MACHINING A DIFFICULT PUNCH AND DIE.

Editor MACHINERY:

Some years ago the writer was called upon to make a punch and die for producing special washers of the shape shown in Fig. 1. These were to be about 1-32 inch thick, 1⅜ inch in diameter, with a ⅜-inch hole, and to have on the periphery 48 saw like teeth. It will be readily seen that the punch and die for such a piece would not be an easy one to file up. The die was made of a block of tool steel 4 inches long by 3 inches wide and about 1 inch in thickness, and in order to cut the teeth, after it had been bored out, the chuck shown in Fig. 2 was employed.

This consisted of a casting *A*, driven onto the steel shank *B* which fitted the index center of a Hendey shaper. The block was held in the chuck by means of four setscrews, *CC*, while its back rested against the face *E*. This chuck was placed in the index center spindle and the center plate elevated so as to give the proper clearance to the teeth which were cut by the tool shown in Fig. 3. The point of this tool was ground to the shape of the teeth to be cut and the chuck was indexed around, 1-48 of a revolution at each cut, until all of the teeth



Chuck and Tool for Making a Difficult Die.

were properly formed. Through the opening *F*, in the back of the chuck, the operator was enabled to observe the work as it progressed.

The punch was made upon a universal milling machine using a cutter of the proper angle for the teeth, and indexing the work in the regular index head. After machining as above described, but little filing was required to fit the punch and die so that they produced most satisfactory results. NIX.

A BORING ATTACHMENT FOR THE LATHE.

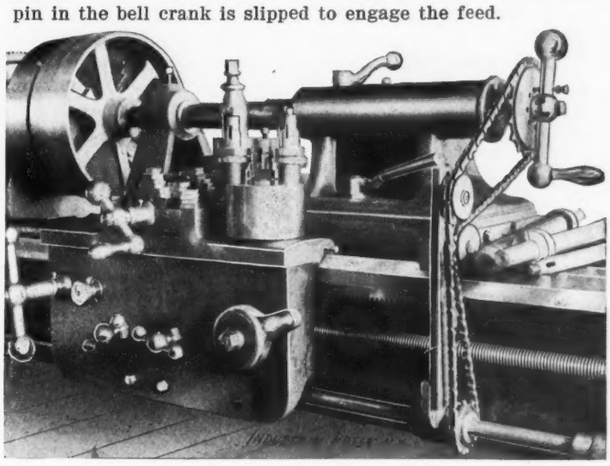
Editor MACHINERY:

The photograph herewith shows a 16-inch lathe as we have fitted it up for boring purposes. The boring bars fit the tailstock spindle, which has a groove planed across its face in which tongues on the bars engage to prevent their turning, thus relieving the taper shank of this duty. The cutter end of the bar is rigidly supported close to the work by the bracket shown in the cut. Flat cutters are used and are held by a set screw in the end of the bar.

The production and maintenance of these cutters being somewhat expensive led to making some special tools which would facilitate their production. After being cut off in a power hack saw they are placed in a shaper and, several at a time, are planed where they straddle the boring bar. They are then finished in a lathe having stub bars, all fitted to one piece, screwed on the nose of the spindle. They are turned and relieved, and after being hardened, are again put in the stub bar and ground with a grinding attachment which is fitted to the lathe. In this manner they are produced rapidly and accurately and when a set is once made it is rarely necessary to make other than finishing cutters as these are ground down for roughing cutters as soon as they wear below size.

The stub arbors and their holders are shown on the right wing of the carriage, one for each size of bar. Some of the cutters are also to be seen on the cross-slide and three of the boring bars are lying on the lathe bed.

The most important part of the outfit is the arrangement of the power feed for the tailstock. An ordinary bicycle chain is used and as the sprocket on the feed rod as well as the idlers are supported from the tailstock, any movement of the latter does not interfere with the action of the feed. The upper sprocket is a running fit on the tailstock feed screw. It has eight holes in its outer face and in one of these holes the spring pin in the bell crank is slipped to engage the feed.



Lathe Fitted with Boring Attachment.

With a single exception the whole arrangement works very satisfactorily; the lathe is a stiff one and the cutters can be fed through at a high rate of feed. Two or three cutters are used, according to the accuracy required, while holes that need to be better than can be produced with a cutter of this kind are reamed by hand after boring. The one fault mentioned is that the feed should engage and disengage at the feed shaft instead of at the tailstock screw, the advantage being that the chain would then stop with the feed. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

TOOLS FOR TURNING AND BORING PISTON RINGS.

Editor MACHINERY:

While the boring and turning of "snap" rings for small engines does not require any great amount of skill on the part of the operator, since a slight variation is allowed on both inside and outside diameters of the rings, yet if they are to be produced in large quantities, the introduction of special tools which will increase the speed of production will be found

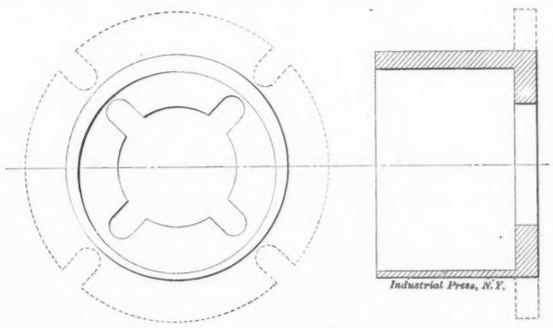


Fig. 1. Casting for Piston Rings.

a good investment. With this object in view the tools here shown were designed, and judging from the increased output they have served the purpose very well.

The tools consist of a bell chuck, cutter head and boring bar. The casting from which the rings were made is shown in Fig. 1 and has a small flange 1 inch wide on the inside for clamping them to the chuck. On the smaller sizes this flange is on the outside, as shown by the dotted lines. There are

four slots cast in the flange which correspond with the slots in the bell chuck, thus doing away with the necessity for drilling bolt holes or for removing the nuts from the bolts in order to remove or replace the work. The bell chuck, shown in Fig. 2, is fitted to the spindle of the lathe and has a series of counterbored seats in the face to receive the different sizes of ring castings. The slots for clamping the bolts, above referred to, are cast at *AA* and are of sufficient length to accommodate all of the sizes of rings.

The boring bar, shown in Fig. 4, is made of a piece of 1½-inch tool steel turned down at the ends to a diameter of 1⅜ inches. These turned portions are eccentric with the remainder of the bar so that when the bar is held by the ends it will have a throw of ⅛ inch. The shorter end has a feather key to correspond with the keyway in the chuck, at *B*, so that the bar revolves with the chuck and the work. The turret head is bushed to 1⅜ inches to receive the long end of the bar.

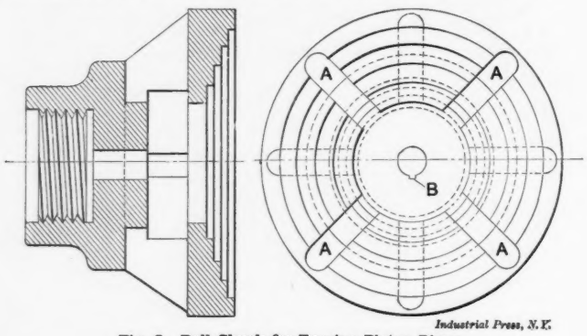


Fig. 2. Bell Chuck for Turning Piston Rings.

The cutter heads, of which there are two, a rougher and a finisher, slide on the bar and have a compound movement due to the eccentric motion of the bar as it travels with the work and to the sliding movement of the turret as it feeds it along to the work. The eccentric motion of the bar causes the cutting tool to advance and recede from the work and thus bore a hole that is ⅛ inch eccentric with the outside of the ring which, at the same time that the boring is in progress, is being turned on the outside with an ordinary turning tool. A slot at *C* in the cutter head, Fig. 3, engages with a lug in the face of the turret and thus prevents the cutter head from turning with the work, at the same time allowing it to move freely with the motion of the bar.

When the casting has been roughed out the bar is withdrawn from the chuck a sufficient distance to allow the roughing head to be removed, and the finishing head is substituted.

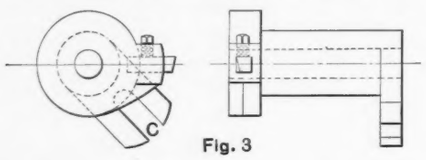


Fig. 3

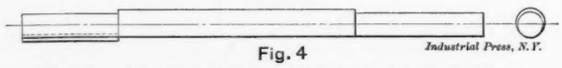


Fig. 4 *Industrial Press, N.Y.*

Figs. 3 and 4. Cutter Head and Bar for Boring Piston Rings.

The ring is then simultaneously finish turned and bored in the same manner in which it was roughed out. A gang tool is used to cut the rings off to the proper width, two rings being cut off at a time. This operation completes the rings and the time occupied is about one-half that formerly required when they were finished by first boring the casting and then shifting the amount required for the eccentricity and turning on the outside. The tools here described were made to fit a 24-inch turret lathe but any stout lathe with turret attachment can be used just as well.

H. H. ESBENSHADE.

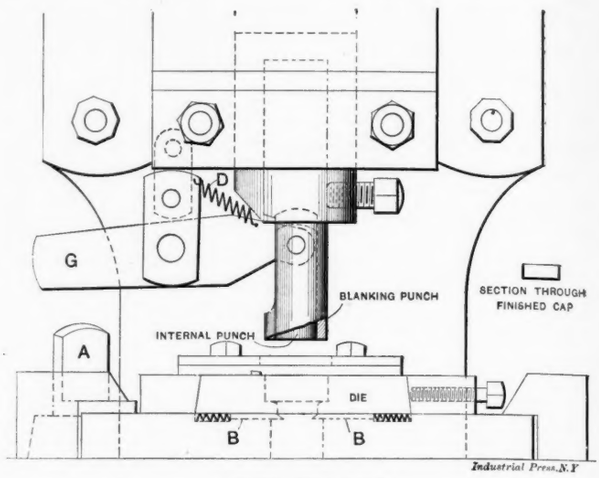
Waynesboro, Pa.

A DOUBLE-ACTING PUNCH FOR A SINGLE-ACTING PRESS.

Editor MACHINERY:

The writer recently had occasion to make 4,000 small brass caps of the shape shown at the right in the accompanying drawing. Having no double-acting press on which these could be punched and drawn simultaneously the method first suggesting itself was to make them in two operations, blanking them out first and then drawing in a second operation. But, as this would entail a double amount of work, after a little consideration the punch here illustrated was designed for punching and drawing the work on a single-acting press, in the same manner in which it would have been done on a double-acting press had one been available.

The die is made in one piece, similar to the ordinary die used on the single-action presses, the only difference being a deeper recess for the blanking punch in order to give a sufficient throw to the internal punch for it to force the cap through the bottom part of the die. As the brass was but No. 24 gage it did not require very great pressure to draw



A Double-acting Punch.

the cap up to the required 5-32 inch in length. When the piece was blanked, the punch was flush with the die and the lever *G* had just come into contact with the stop *A* which, as the punch continued to descend, caused the internal punch to move forward ahead of the blanking punch and force the punching through the die, thereby forming the cap in a single operation. As the blanking punch was withdrawn the strippers *B B* relieved the cap from the internal punch and the spring *D* returned it to its original position within the blanking punch.

GEO. C. REITH.

Philadelphia, Pa.

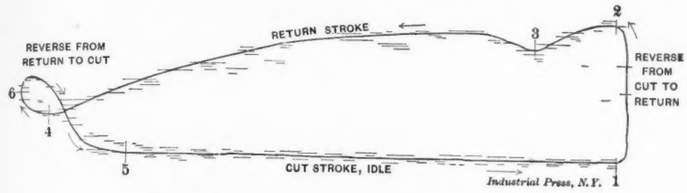
PLANER INDICATOR DIAGRAMS.

Editor MACHINERY:

The advent of individually motor-driven machine tools has, by direct electrical measurements and readings from dial instruments, resulted in a ready determination of the power required to drive them. This has been very satisfactory for those tools in which the power consumption varied but slowly, but less so with others, such as planers, with which the rapid changes at the ends of the stroke made accurate readings of the fast moving needle rather difficult. On studying the influence of belt speed and shifting rate on the action of the planer it became plain that a power diagram, analogous to that used in steam engines, which would give a graphic picture of the occurrences throughout the stroke, and more particularly of those at reversal, would be very desirable. An electrical instrument maker undertook the building of suitable apparatus which consisted of a special type of amperemeter, with a recording drum, etc., arranged very much as the usual engine indicator. The drum, carrying the paper, was rotated from the planer table through a reducing gear. As the makers thought that the friction of the pencil would too seriously dampen the action of the ampere meter needle, this was brought into contact with the paper at short intervals only. A stirrup, wide enough to cover the entire field of the needle, was from time to time depressed by clockwork and in turn insured the momentary contact of the pencil carried by the needle. This explains the peculiar appearance of the diagram, which is made up of a series of horizontal dashes; the one shown representing a number of consecutive table strokes. The continuous curve was

drawn in by hand. The general outline is characteristic of all obtained on various planers.

The power taken on the cut stroke, idle, is constant. At 1 a very rapid power increase is started to reverse the table to the return; the almost vertical rise shows that it is very sudden. Then a gradual fall of power takes place during the whole of the return stroke, except near the start, where there is, from 2 to 3, a peculiar dip and recovery. The absence of a steep peak at 2 shows that the width and speed of the belt have been well chosen and that the reversing cam has been



A Typical Planer Indicator Diagram.

correctly designed, all working together harmoniously. It is natural to expect that, once the return is well started, the power would remain fairly constant to the beginning of the next reverse; but the diagram shows a continuous drop; this is characteristic of all tests made on other sizes of planers also, and an appearance which the writer is at a loss to satisfactorily explain. At 4 the change into the cut stroke begins to make itself felt by an increase of power beyond the actual reverse; the power then gradually and smoothly drops to that taken throughout the cut stroke. It is the continuance of the power rise beyond the actual reversal that causes the rather unexpected loop at this end of the diagram. This also is a general characteristic. Though at first sight this loop appeared anomalous a little reasoning shows it to be expected. To overcome the inertia of the fast running pulleys in reversing them calls for an increase of power; as the beginning of the reverse

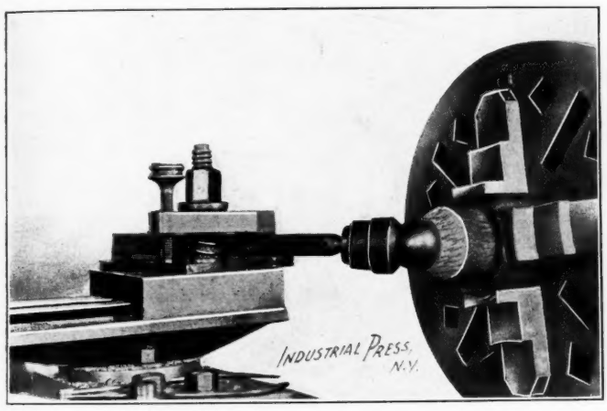


Fig. 1. Another Method of Turning a Ball

takes place during the return stroke the power must rise near the latter's end, attain a maximum at about the time when the reversal has been effected and then fall. As the power during the cut is less than during the return the curves must cross and form a loop. At the change from cut to return the same phenomena occur, but manifest themselves as a dip instead of a loop, because the power required at the beginning of the return does not fall as low as that taken by the cut stroke, so that the curves, though approaching, do not cross to form a loop; the action at both ends is similar, varying only in degree. The motors used were all of the three-phase, alternating current type, with 50 periods per second.

Philadelphia, Pa. HENRY HESS.

ANOTHER METHOD OF TURNING A BALL.

Editor MACHINERY:

The writer has read with much interest the article in the June number of MACHINERY upon the subject of ball turning. In the shops of Messrs. Richard Pohle & Co., Riga, Russia, many balls are turned, for valve purposes, in what is believed to be a faster and more accurate method than that described by Mr. Otis. The balls are first turned on centers to a diameter about 1-64 inch greater than the finished size and as nearly round as possible. The centers are then cut off and the balls finished in the arrangement shown in the photograph, Fig. 1.

A piece of hard wood is put in the chuck and bored out to fit nearly one-half of the ball. The finishing tool consists of a single piece of steel bored out to a diameter of from 55 to 66 per cent. of the diameter of the ball. The cutting edge at *AA*, Fig. 2, must be very sharp and perfectly circular, and when grinding is necessary, it should be done on a machine to insure accurate results.

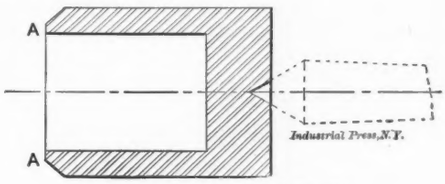


Fig. 2. Tool used for Ball Turning.

The ball is placed in the wooden chuck and the tool pressed against it at an angle of about 45 degrees. While revolving, both the ball and the tool will rotate against one another and in a short time the ball will be cut perfectly round and smooth. Naturally, both ball and tool will heat very considerably, so that it is necessary to cool the ball in water. It is, therefore, a good plan to turn two balls at once so that one may be cooling in the water while the other is in the chuck. This method has been employed for a number of years and has always produced very good results. The photograph was taken when turning a ball 2 inches in diameter. A. WIND.

Riga, Russia.

FACING AND COUNTERBORING LARGE SPIDER CASTINGS IN THE DRILL PRESS.

Editor MACHINERY:

In a shop where paint mixing machines are built the writer came across a method of facing and counterboring large castings in the drill press which may prove suggestive to readers for the machining of other work in a like manner. An idea of the shape and size of the castings may be gained from Fig. 1, in which is shown the nature of the work to be done. As will be seen the casting has two hubs which are required to be bored to a finished diameter of 5 inches, then faced at *AA*, *BB*, *CC*, and *DD*, respectively, and lastly counterbored at *FF* to a depth of 1 inch and a diameter of 7 inches. It is at once obvious that the large drill press which is equipped with a floor base is the proper machine for the work, and that it would be very difficult to do the work in any other machine.

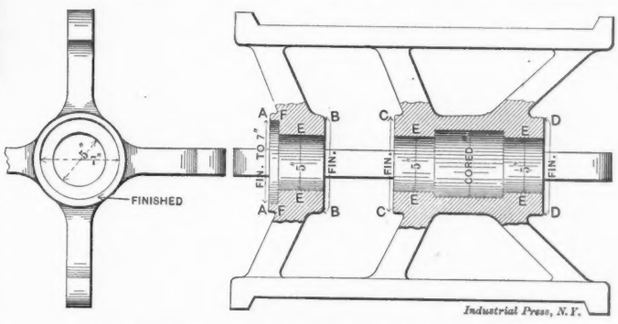


FIG.1. CASTING AS BORED, FACED, AND COUNTERBORED.

The boring to a finish of the cored holes in the hubs presented no unusual difficulties; a large boring bar of approved construction being used and the projecting end allowed to run in a bushing, bolted to the floor base of the drill, to which the work was strapped. To accomplish the facing of the four hub faces and the counterboring of the seat in an expeditious and accurate manner, however, required other means than those used for the boring. It was for this work that the special facing and counterboring tool illustrated in Fig. 2 was used.

As will be seen the special tool consists of the regulation bar, turned taper at one end to fit the drill press spindle, and rounded at the other to enter easily the supporting bushing on the

base of the press. This bar has five holes let through it to accommodate the boring head. The holes are indicated in the engravings by letters *C*, *D*, *E* and *F* respectively. Three holes are for the cutter bar and the other two are tapped holes for the feed screw *G*. In the cutter head, *H* is the bar, *O* the "goose neck" cutting tool, a seat for which is provided in the cutter clamps *M* at either side of the center as the taking of under and upper cuts necessitates. *I* is the connecting strap between the cutter bar and the feed screw; *J* the bar-fastening nut; *G* the feed screw and *K* the hand knob. *N* is a cap screw used for fastening the cutter and cutter straps to the cutter bar.

In using this tool the bar was projected down through the hubs of the casting until the end ran in the supporting bushing at the base. The cutter head was then in the position shown in Fig. 2. First the surface *A* was faced, the feed screw being turned a little by hand at each revolution—the large

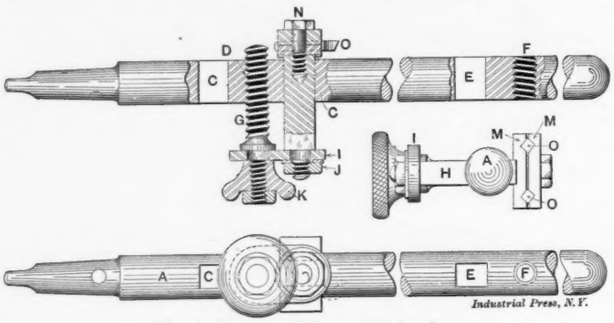


Fig. 2. Facing and Counterboring Bar.

opening making this an easy matter. Next the seat *FF* was bored and finished in the same manner, feeding the spindle of the drill down for depth and the feed screw of the cutter head for diameter. After this the under face of the upper hub was faced by removing the cutter head entirely; feeding the spindle downward until the upper three holes in the bar were clear of the under face of the upper hub; then relocating the cutter head with the feed screw in the same hole as it occupied in the first instance; but with the cutter bar in the upper hole *C*. Thus the cutter bar was merely reversed and the facing of the under side of the hub accomplished by feeding the spindle up instead of down. The two faces of the lower hub were faced in the same manner, the cutter head being removed and reversed as required.

J. V. WOODWORTH.

Brooklyn, N. Y.

THE STRENGTH OF GEAR TEETH.

Editor MACHINERY:

From time to time much valuable information has been published in the columns of MACHINERY relative to the strength of gear teeth; and the formulas by Mr. Wilfred Lewis, reproduced in the July data sheet, accompanying the Engineering Edition, are very valuable to those who have to make calculations concerning the strength of the standard gears—or rather the safe load, as the formulas do not give the ultimate strengths.

In one case, however, which recently came to the writer's attention the Lewis formulas did not seem to call for a gear strong enough for the given purpose. In this case the writer was called upon to design a large cast-iron gear to run at a speed of 100 feet per minute and to carry an extremely heavy load. Lewis' formulas having been used with good results at higher speed, it was natural to suppose that they would apply equally well to this case. As this gear was too large for the shop to handle the design was submitted to several of the parties who make a specialty of large gear work and their opinion was asked as to its fitness to stand the load for which it was designed. Without exception they replied that the gear was not strong enough for the required duty and when the gear tooth was calculated as a cantilever beam, assuming the load to come at the top of the tooth, it was decided that the proper factor of safety had not been allowed.

The writer then began to study the subject more fully with the object of finding a formula which would give the ultimate strength as well as the safe load, so as to be able to vary the factor of safety to suit the given case, and also to calculate the strength of tooth when made shorter than the standard depth. There are so many rules for the strength of gear teeth that there is probably much truth in the statement made in Grant's gear book that, "If a gear tooth should break, the designer can always find a rule to prove that it must have met with an accident, as it was properly designed." It seems to me that the best way to treat this subject is to first calculate the ultimate strength of the tooth and then divide by the proper factor of safety to get the safe load at the pitch circle.

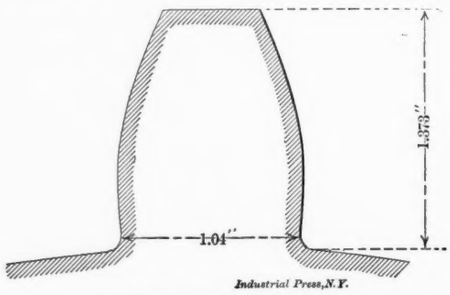
Among Cooper's collection of 24 rules from different writers, published in the *Journal of the Franklin Institute*, July, 1879, will be found the following method, which was used by James Watt to find the ultimate strength of cast-iron gear teeth. He found that a bar of 1-inch square cast-iron would break if a load of 600 pounds be applied at a distance of 12 inches from the point of support; then if the load was applied at 1 inch from the point of support, the bar would break with a load of $12 \times 600 = 7{,}200$ pounds. Hence the following formula for the ultimate strength of cast-iron gears:

$$U.\,S. = \frac{7{,}200 \times (\text{thickness of tooth at root})^2 \times \text{length of face}}{\text{full depth of tooth.}}$$

For example: What would be the ultimate strength of a cast-iron gear tooth of 2-inch circular pitch, 5-inch face; the gear having 30 teeth? The figure shows the thickness of the tooth at the root to be 1.04 inch and the depth of tooth 1.373 inch. Then:

$$U.\,S. = \frac{7{,}200 \times (1.04)^2 \times 5}{1.373} = 28{,}300 \text{ pounds.}$$

This rule, however, would require cast-iron to have an ultimate strength of flexure of 43,200 pounds, whereas for ordi-



Tooth of Gear used in Example.

nary cast-iron most authorities give 36,000 pounds per square inch. Assuming the latter value and calculating for a beam of 1 inch square section and 1 inch deep, we have:

$W\,l = S\,R.$

$W =$ Breaking strength in pounds.

$l = 1.$

$S = 36{,}000.$

$$R = \frac{(\text{side of square})^3}{6} = \tfrac{1}{6} = \text{moment of resistance.}$$

Then

$$W = \frac{36{,}000}{6} = 6{,}000 \text{ pounds.}$$

and for safety, unless the ultimate strength of flexure is known, it would be better to use 6,000 pounds in the formula in lieu of 7,200 pounds.

Substituting this value in the above example the ultimate strength of the tooth would equal

$$\frac{6{,}000 \times (1.04)^2 \times 5}{1.373} = 23{,}600$$

Whenever the ultimate strength of flexure is known for any material, take one-sixth of the value for use in the formula.

Having found the ultimate strength of the tooth, the next step in order is to find the safe load. This would depend upon the speed at the pitch circle; for as the speed increases, the liability of the tooth breaking from shock becomes greater. The following factors of safety and corresponding speeds have

been computed by the writer as giving good average results:

Speed of teeth in ft. per min...	100 or less	200	300	400	500	600	900	1200	1800	2400
Factor of safety.	3½	4½	5½	6	6½	6½	8½	11	13	15

For example: What is the safe load of the above gear running at 20 revolutions per minute, taking 36,000 pounds as the ultimate strength of flexure?

$$\text{Speed in feet per min.} = 20 \times \frac{2 \times 30}{12} = 100$$

Corresponding factor of safety = 3½.

Then

$$\text{Safe load} = \frac{23{,}600}{3.5} = 6{,}743 \text{ pounds.}$$

The safe load for this gear as figured by Lewis' formulas would be:

$8{,}000 \times 2 \times 5 \times .102 = 8{,}160$ pounds, indicating a considerable less factor of safety than when figured by the other formula. Some authorities claim that cast-iron should never be strained beyond one-third of its ultimate breaking strength, as that is the elastic limit for the material.

For the same gear in steel having an ultimate strength of flexure of 120,000, the ultimate strength would equal

$$\frac{\frac{120{,}000}{6} \times (1.04)^2 \times 5}{1.373} = 78{,}660 \text{ pounds,}$$

and the safe load would be

$$\frac{78{,}660}{3.5} = 22{,}474 \text{ pounds.}$$

Lewis gives for a safe load for steel 20,000, so that by his formulas the safe load would be $20{,}000 \times 2 \times 5 \times .102 = 20{,}400$ pounds, giving in this case a smaller value than that obtained by the other formula, therefore indicating that a greater factor of safety has been used.

J. T. GIDDINGS.

East Providence, R. I.

[In the above discussion of the strength of gear teeth no consideration has been taken of the shape of the tooth, the weakest point being assumed in all cases to be at the root of the tooth. In Mr. Lewis' investigation he systematically determined this point from a series of drawings of involute cycloidal and radial flank teeth and his formulas, based upon this investigation, are generally accepted as the most reliable data at present published concerning the strength of gear teeth. They are, however, open to criticism in the matter here referred to, in that the strengths of iron and steel are assumed and the results given in safe strengths. If in the place of the values S given by Mr. Lewis we substitute the ultimate strength of the material considered there is no doubt that the formulas will give more reliable values for the strength of the three forms of teeth considered than any other method of calculation. For special forms of teeth, stub teeth, etc., it is sufficiently accurate to figure them as a simple beam with the weakest point at the root of the tooth; for whatever error may then occur will be upon the safe side for strength, and for the investigation of gear teeth in this manner the formulas here presented by Mr. Giddings will be found perfectly reliable and in very convenient form for use.—EDITOR.]

A MILLING FIXTURE.

Editor MACHINERY:

The piece shown in Fig. 1 is a latch chuck, made of cold rolled steel, that is used on a special machine for holding the ends of rods. The body and the center holes on both ends were turned in the lathe and the other holes were drilled in a special jig. The fixture shown in Fig. 2 was designed for holding the chuck while milling the longitudinal slot to receive the latch which was required to be exactly central with the axis of the piece. While not of unusual design, it possesses some advantages that make it especially useful when it is necessary to perform milling operations of this nature. It is so made as to be free from any outside incumbrances and the parts where wear is likely to become appreciable are carefully hardened. The clamping mechanism is of a gradual wedging action thereby holding the work securely and at the same time permitting the quick removal of one piece and the insertion of another by simply turning the milled knob to the right or left as may be desired. As will be seen, the clamping mechanism is entirely enclosed, thus avoiding dust and dirt and lessening the liability to accident from any external cause. While the illustration shows only one way in which this device may be employed, a wider field of application will without doubt suggest itself to the reader, as it is suitable for holding all kinds of milling jobs, especially where the work is polished and would be marred by clamping in a vise in the ordinary manner.

The fixture is made of liberal proportions, to insure rigidity, and is tongued and slotted for clamping bolts. Through the center of the body of the fixture is drilled a hole carrying the tightening clamp B, the larger diameter of which fits snugly in the hole while the neck is turned down and threaded to fit the clamping knob C. To prevent the piece from turning, when the knob is turned, a groove is cut the entire length of the larger diameter and into this fits the point of the setscrew D. The upper face of B is milled flat on a taper of 1 inch per foot and this part of the piece is made very hard. When clamping the work, the shoulder of the knob brings up against the body of the jig at E; on reversing, the two screws FF, with their points seated in a rounded groove in the knob, prevent it from being withdrawn.

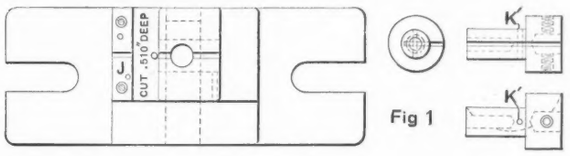


Fig 1

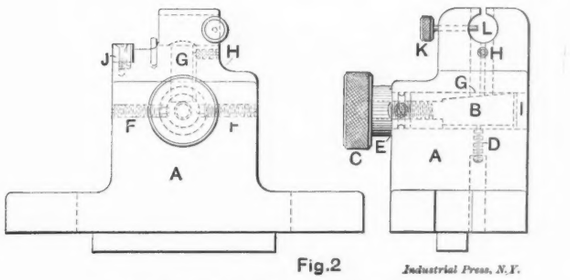


Fig.2

Industrial Press, N.Y.

Fixture for Milling Slot in Latch Chuck.

The semi-circular faced plug G stands vertically in the position shown, one end resting on the inclined face of B and the other bored out to conform to the diameter of the work. A spline is cut on one side to receive the point of the screw H which, while permitting a free movement up and down, checks any tendency for the piece to rotate. This plug fits the hole so freely that when it is released it falls away from the work by gravity. When the parts of the fixture are assembled the chamber in which the slide B is located is filled with vaseline and the plug I driven in, thereby completely enclosing the mechanism and preventing the ingress of grit or the escape of oil.

The milling of the slot in the work is performed with an ordinary metal saw of the required width; setting it central is simplified and facilitated by the set gage J, which is of tool steel, hardened and fastened in place with screws and dowel pins. The depth to be cut is measured by the graduated dial on the milling machine. In this case it is .510 inch, and this is stamped upon the fixture for convenience of future reference. To operate the fixture the pin K is withdrawn a sufficient amount to clear the hole L and the nose of the chuck to be milled is inserted against the stop pin. The chuck is rotated by hand, at the same time pressing upon the head of the pin K, until the pin slips into the fulcrum pin hole for the latch, K^1, Fig. 1, that has been previously drilled in the work. A turn of the knob C then clamps it tightly for the milling operation.

C. H. ROWE.

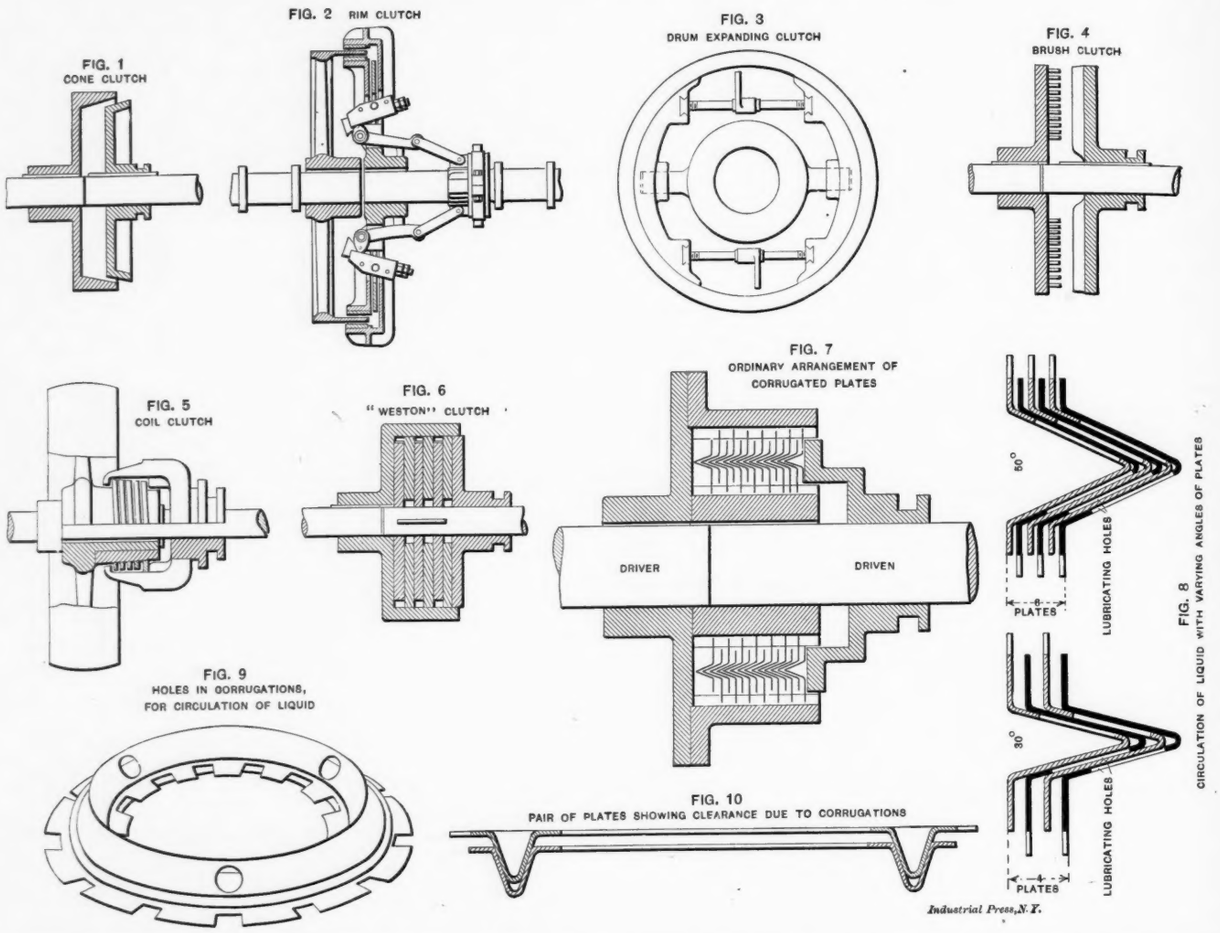
Salem, Mass.

A NEW FORM OF FRICTION CLUTCH.*

The friction clutch is a very old invention, and is probably as familiar to every one in its simplest form as any other machine detail. It is, however, only in recent years that inventors have, in any great numbers, seriously attempted to overcome the defects of the ordinary cone clutch, and their attempts have been attended with such success as to lead to the introduction of a very large number of clutches of moderate power into machinery. This is proved by the fact that in recent years a good many engineering workshops have been devoted, either wholly or in part, to the manufacture of clutches of certain well-known forms. A number of such makers have supplied clutches for many thousands of horse power for purposes in which they were little used a few years ago. A familiar illustration is the extensive introduction of friction clutches to countershafts in place of the ordinary fast and loose pulley. It might therefore be thought at first that, in an apparently simple matter, there was very little more to be said and nothing more to be discovered. The importance of the friction clutch, however, justifies a very careful consideration of the problem, as to whether, in view of the modern developments of motive power, particularly in internal-combustion engines and of high-speed machinery of great power, there are not yet improvements possible in this subject.

The usual object of a friction clutch is to impart motion from a piece of machinery to another piece of machinery at rest, and thus the friction clutch differs in its object, in a very essential manner, from any ordinary form of coupling, or from the well-known jaw clutch. In the latter there is not—or should not be—any relative motion between the parts connected. Hence the strains involved are of a statical nature, and, however great, do not involve a mutual action of the nature of a shock, whereas where two pieces of machinery, not having the same speed, have to be connected with each other, there would be a shock due to inertia, unless the connection was made by means of a friction clutch, or some equivalent, such as a slipping belt, allowing the two pieces of machinery to gradually come to the same speed. This gradual effect is therefore the primary object of the friction clutch, and how important this object is, will be realized when it is remembered that it is impracticable to start any machine instantaneously, for the magnitude of the stresses and strain caused when a machine is set in motion by another, increases with the suddenness of the operation, and all appreciable shock can be obviated by allowing the action to take place gradually.

During the whole time that the two pieces of machinery are coming to one speed—which in the case of the friction clutch is caused by one starting another into motion, while in the case of a brake it is caused by one bringing the other to rest—during this time work is being lost at the surfaces where the slipping is taking place, and consequently heat is generated. The more gradual the action, therefore, the greater the amount of heat, which reaches its greatest amount in the case of the friction dynamometer, where slipping takes place the whole time, and all the work of the moving machine is converted by the friction into heat. Further, it may be said—speaking practically—that wherever there is friction between two surfaces, there is a certain amount of wear taking place, which may be diminished by the use of suitable lubricants. The better, however, the surface is lubricated, the less the effect of friction, and consequently the less the gripping power of the clutch.



Stated briefly, the four conditions which seem to be involved in the problem of the friction clutch are:

1. It must have sufficient gripping power.
2. Undue wearing of the surfaces must be avoided.
3. Provision must be made for conveying away the heat where there is much slipping contact in the clutch.
4. Motion should be imparted to the driven shaft without shock.

We are thus met at the outset with the contradictory conditions which have made the problem of the friction clutch such a difficult one. The author does not remember seeing in any

* Paper read by Prof. H. S. Hele Shaw before Institution of Mechanical Engineers, Leeds, England.

previous writings on the subject, or in the statement of inventors themselves, the important fact mentioned in condition 3, but it certainly does account for the large number of instances in which friction clutches have failed to give satisfactory results for anything but the smallest powers.

Looking at the various clutches in use they may be classified and represented diagrammatically as follows:

1. The cone clutch, Fig. 1, where considerable pressure between the surfaces is obtained by the wedge action of the cone.

2. Various forms of rim clutch, Fig. 2, in which the action is obtained by means of levers.

3. Clutches with rings or segments expanding within a drum or annulus, Fig. 3.

4. The brush clutch, Fig. 4, in which brushes of wire are thrust into a finely serrated or grooved plate.

5. The coil clutch, Fig. 5, in which a coil of metal or wire rope with blocks is employed to give great gripping power.

6. The "Weston" clutch, Fig. 6, in which the friction effect is produced by a number of circular disks connected alternately with the driving and driven machine.

FIG. 11
TYPE OF OPEN CLUTCH WITH AIR COOLING, SHOWING TRIGGERS FOR HOLDING OFF PRESSURE

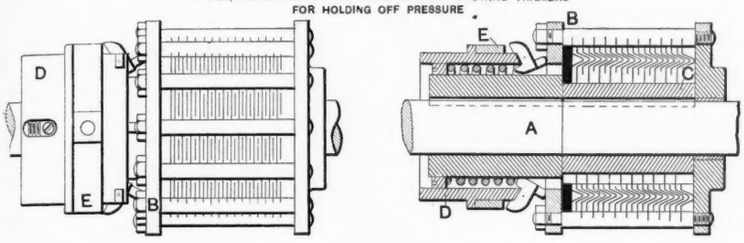


FIG. 12
CLOSED CLUTCH

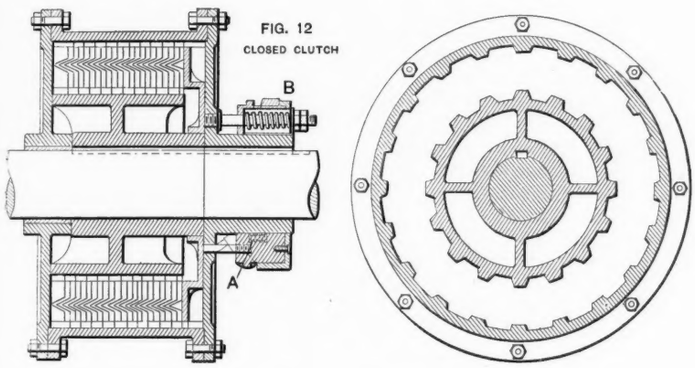
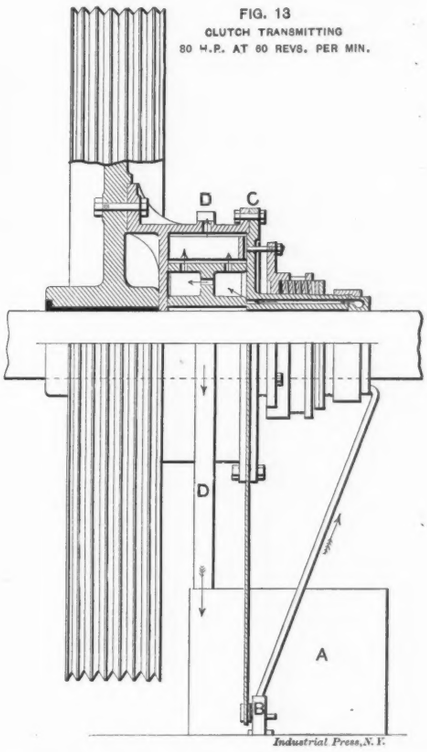


FIG. 13
CLUTCH TRANSMITTING 80 H.P. AT 60 REVS. PER MIN.



Industrial Press, N. Y.

There are numerous modifications in detail of all these clutches, but the inventions in connection with them—which are very numerous—relate principally to the mode of obtaining the requisite pressure between the friction surfaces. Thus taking the case of the expanding ring or segment, which is one of the most successful forms, wedges, right and left-handed screws, and toggle-joints have all been used in different ways for expanding the rings or segments; but no clutches appear to have been designed for the purpose of allowing slipping to take place to any considerable extent, so as to prevent, at the same time, undue wearing and heating of the friction surfaces. These clutches, if not transmitting considerable power and not required to slip, serve their purpose very well. Some, such as the coil clutch, the "Weston" clutch, and the expanding ring clutch, may be made to transmit great powers, but it may be safely said that not one of the foregoing clutches has yet been designed so as to be capable of slipping for more than a very short time, without being seriously injured, even if the surfaces in contact were not actually destroyed.

There are plenty of illustrations in mechanical science where it has hitherto been impossible to reconcile conflicting conditions such, for instance, as the variable change speed gear, especially when required to be of high power and high efficiency, and it is an important question whether the present case forms another example or not. The author believes there is a way out of the difficulty, and this he proposes to bring forward in the present paper. It is quite possible that there are other ways, and if engineers consider the matter of sufficient importance, it may put them on the track of overcoming the difficulty by a way other than that which will now be described.

Suppose a sheet of metal is pressed into a frustum, the section of the corrugation being the frustum of a cone, and that the disk is placed upon another one similarly corrugated. It will be observed that not only do portions of the frusta not make contact with each other, but there is also a space left between the flat portions of the disks.

By placing these disks together as in Fig. 10 and turning one alternately to the other, an amount of friction is produced which depends on the acuteness of the angle of the frusta. If a number of these plates are now placed in a box of the type of the "Weston" coupling, so that the plates alternately engage with two sleeves, one connected with the driver and the other with the follower, as in Fig. 7, it will be found—first, there is very considerable gripping power; second, there is a tendency to part rapidly with heat, owing to the separation of the disks of metal.

By the ordinary theory of friction, the former effect—in a box of given length, if the gripping power is compared by actual measurement with the "Weston" clutch—will be found to be much greater, and yet this cannot be accounted for by the ordinary laws of friction, since the increased effect of the wedge action (which varies with the cosecant of the angle of the cone) is directly in proportion to the diminution in the number of plates which it is possible to put in a box, which diminution varies according to the same law. There is, however, a still more striking difference between the gripping action of the flat and corrugated plates when a lubricant is introduced.

Efficient lubrication of the surfaces in contact is insured by drilling the faces of the plates as shown in the sectional view, Fig. 8, and in the perspective view, Fig. 9. It will be noticed from this illustration that the number of plates in a given space depends upon the angle of the corrugation, thus: Four plates with 30 degrees occupy the same space as six plates with 50 degrees. These four plates, however, give a better grip than the six plates with 50 degrees, and have the great advantage

of allowing a freer circulation of liquid, as may be easily seen from the figure. The plates are also much more rigid with the more acute angle.

Two views of a standard type of clutch for shafts up to 2 inches in diameter are shown in Fig. 11. The shaft is divided at *A*, the outside case *B* being keyed to the left-hand piece of shafting, and driving the set of plates having external driving teeth. The core *C* keyed to the right-hand shaft drives the plates with internal driving teeth. Pressure is applied to the plates as follows: The sliding sleeve *D*, containing a coil spring, is fitted with pins, which project through the outside case of the clutch; these pins press against a flat disk, which in turn presses against the plates, causing the clutch to drive. When the operating lever is worked so as to release the plates, the ring *E* encircling the sleeve withdraws the trigger pins from the holes into which they fit; the spring pressing on the opposite end of the trigger pin causes the trigger to fly up, and the clutch is thereby kept out of operation. By moving the lever so as to force the ring *E* against the trigger, the pin end falls into the hole opposite to it, and the coil spring is then allowed to transmit its pressure to the plates.

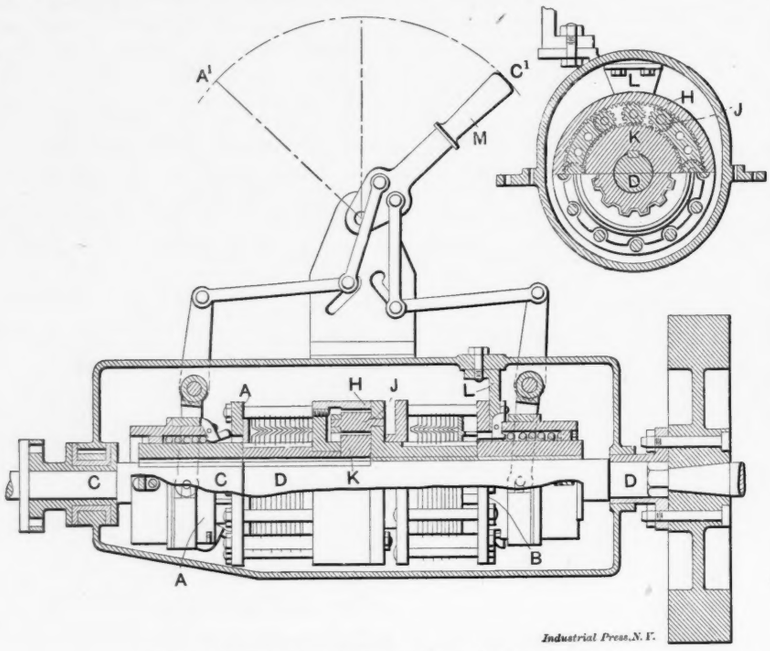


Fig. 14. Reversing Gear with New Form of Friction Clutch.

A view of a clutch transmitting 80 horse power at 60 revolutions per minute is given in Fig. 13. One of the conditions of working of this clutch is that it should run for at least two hours daily transmitting only 30 horse power, the main shafting running at its full speed of 60 revolutions. It must pick up its load gradually and without shock. The cooling and lubricating fluid is contained in the tank *A* placed on the ground. The fluid is raised to the clutch case by means of the small rotary pump *B*, driven by a band from the clutch case at *C*, the path of the fluid being indicated by arrows. It leaves the casing through a series of holes in the periphery, being discharged through these by centrifugal action. It is then collected in the annular trough *D*, which, fitting loosely over the revolving casing, directs the fluid back into the supply tank *A*. This clutch has been at work at Pilkington's plate glass works, St. Helens, for a period of five months, running day and night, and fulfilling every requirement satisfactorily.

The clutch is the chief factor in a wheel train reversing gear, and the author has recently designed such a reversing gear in which the new clutch is employed. This reversing gear, shown in Fig. 14, consists of two clutches, *A* and *B*. The outer case of the clutch *A* is keyed to the reversing shaft *C*, which may be a propeller shaft, the core of *A* being keyed to the engine shaft *D*. Inside the rim of the outer case of *A*, teeth are cut in the direction of the shaft, forming an annular wheel *H*. To the internal core of clutch *B* a series of pinions are fixed, as shown at *J*; these pinions gear with the annular wheel *H*. They also gear with the wheel *K*, keyed to the engine shaft, the three together forming an epicyclic train. The outer case of *B* is held stationary, being fixed to the frame of the machine by a bracket *L*.

The gear operates as follows: When the lever *M* is in position C^1, clutch *A* is made free and clutch *B* comes into action. The core of *B* carrying the pinions *J* is now fixed to the outside case of clutch *B* (which is permanently at rest), and, as the core of *B* is free on the engine shaft, the toothed wheel keyed to this shaft at *K* transmits motion to the pinions, which, being also in gear with the outside case of *A*, causes the shaft *C*, to which *A* is fixed, to rotate in a reverse direction and at a slower speed than that of the engine. When the operating lever *M* is in mid-position, both clutches are inoperative and the reversing shaft is at rest. When the lever *M* is in position A^1, clutch *B* is free; at the same time the plates in clutch *A* are caused to grip, and as the outside case of *A* is keyed to the reversing shaft and the core of *A* to the engine shaft, the two rotate together in the same direction. The toothed gearing at *H*, *J*, and *K* now rotate as a fixed mass, the teeth themselves not being in operation.

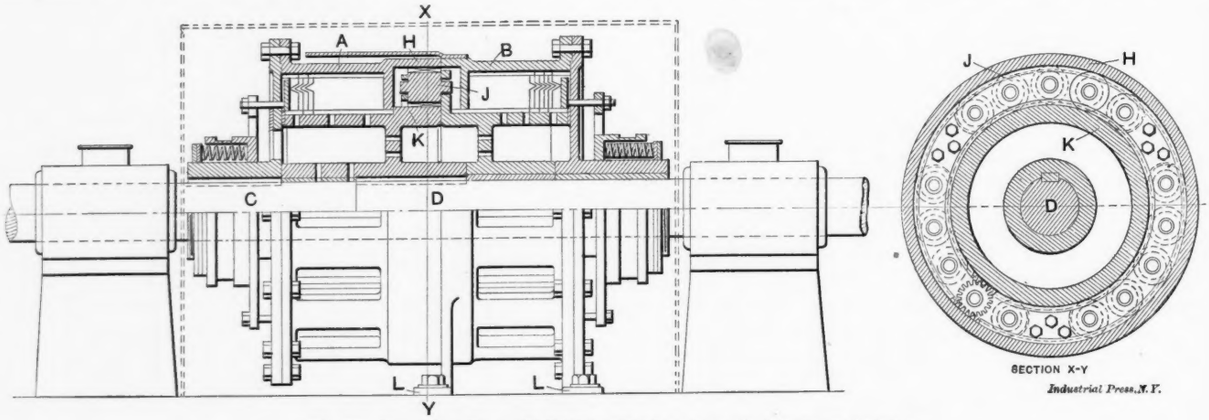


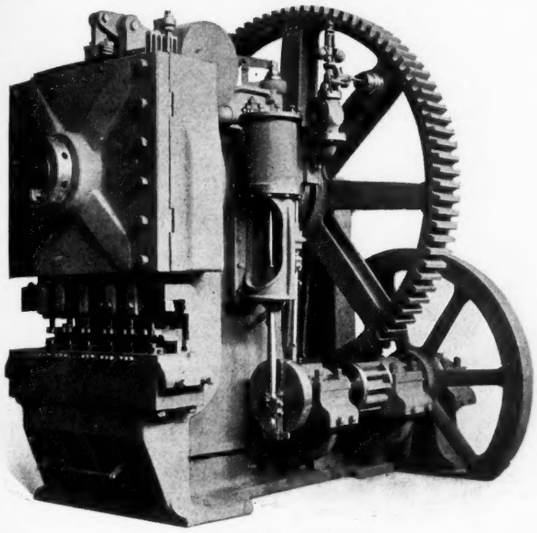
Fig. 15. Reversing Gear with Friction Clutches, as applied to Steam Turbine.

Fig. 12 shows a section of a larger type of clutch as fitted to a 3-inch shaft. The action of this clutch is similar to that described in Fig. 11. The triggers, however, are worked by separate coil springs, *A*; the pressure is also applied to the plates by means of separate springs, *B*, instead of a single one, as in the type illustrated in Fig. 11. A considerable amount of lubricant can be contained in this clutch owing to the construction of the casing. The right-hand view indicates in section the form of driving teeth adopted.

The presser rings of clutches *A* and *B* on this gear are fitted with the spring and trigger arrangement described previously in connection with Fig. 11.

The locking system of operating links and levers renders it impossible for both clutches to grip simultaneously, no matter how suddenly the operating lever *M* may be moved from one extreme position to the other. The inclosing case of the whole gear acts as an oil bath, and thereby insures an efficient system of lubrication.

Fig. 16 shows the design of a reversing gear of this type for a steam turbine of 1,000 horse power, the number of revolutions per minute being 700 to 800. The action of this type of reversing gear may be made as quick or slow as desired, but with a fairly heavy flywheel attached to the gear it has been found possible to change from full speed in one direction to full speed in the opposite direction in five seconds.



Steel Splice Bar Press

A satisfactory clutch is one of the most difficult things to secure for automobile purposes. The ordinary type of cone clutch, which is generally employed, the cone of which is covered with leather, can rarely be maintained in a normal condition, for the following reasons: A great command over the car, especially in driving through traffic, is secured by allowing the clutch to slip. When slipping has been going on for some time the surfaces are generally so altered in their condition that either the clutch will not grip at all or it grips violently and harshly. The result in driving is not only most unpleasant, but it is very inimical to the car itself.

One of these clutches has been fitted to a fairly heavy car, on which the engines had been changed from 6 to 12 horse power. This clutch, although the plates were only 6 inches in diameter, drove the car so satisfactorily that the 6 horse power gear has, under very trying conditions of the British Association tests on road resistance, been found quite strong enough for the purpose. Since then the cone clutch of a 24 horse power Darracq car has been changed for one of the type here described, with remarkable improvement in its action. It has been found capable of driving the car so altered, although a fairly heavy one, for long distances, even in hilly country and without ever going off top speed, which is a direct gear to the driving wheels. The actual speed at the normal revolutions of the engine on this car is 70 kilometers (i. e., about 45 miles) per hour. This example shows the possibilities of the clutch, with which the car can be driven for any required distance at the speed of 3 or 4 miles per hour, or even less, and after running for an hour or two under these conditions the clutch does not get hot. Of course, the main object of the change gear, which is to increase the power if necessary, is not attained, since the slipping of the clutch can only involve loss of power; but this is a case in which, with an engine of sufficient power, variation in the range of speed is really a more important object than the saving in power.

* * *

A LARGE SPLICE BAR PRESS.

The use of steel in machine construction has of late been finding much favor with machine builders and an example of what may be accomplished in this direction is well illustrated by the splice bar press that has lately been built by the Long & Allstater Co., Hamilton, Ohio, and is illustrated in the photograph herewith. While the working construction of this press is not particularly out of the ordinary it is nevertheless quite remarkable for the materials that have been used and for the weight of the parts. The press complete has a total weight of 86,000 pounds and, with the exception of the engine, is made wholly of steel, the main casting alone weighing 43,000 pounds. The crankshaft is a nickel steel forging and all of its journal bearings are lined with bronze bushings. These bushings are required on account of the steel construction which makes it necessary that all working bearings must be lined with bronze to prevent the running of steel on steel. Consequently not only the shaft but the slide body, cam and cam pintle, which gives the movement to the slide, are all bronze bushed and the slide has bronze gibs for taking up the wear on the front, back and each side. The jaws on the clutch and wheel are faced with tempered steel plates, which may be removed and renewed when they become worn.

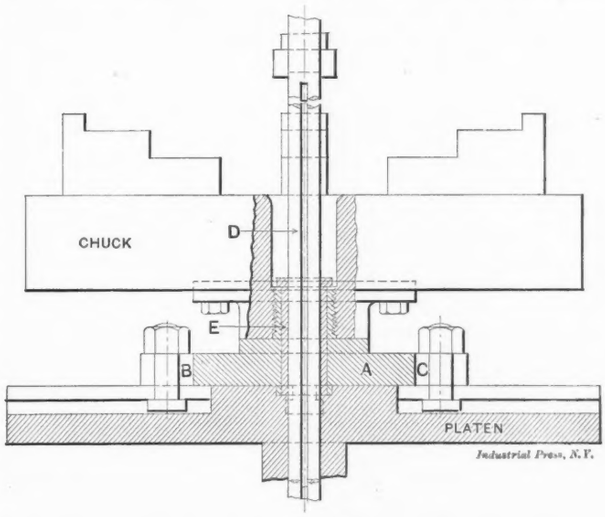
The slide is counterbalanced and the machine is driven by a direct-connected engine. It has a capacity for punching at one stroke six holes through 1 inch thickness of nickel-steel splice bars. The punch and die holder may be adjusted up to a distance of 40 inches from center to center of the outside holes. The main objection to the use of steel for machine construction has been the difficulty of procuring satisfactory castings of large size, but the construction of such a machine as this certainly indicates that there is now no limit, within ordinary ranges, to the use of cast steel for machine building.

* * *

CONTRIBUTED NOTES AND SHOP KINKS.

UNIVERSAL CHUCK FOR DRILL PRESS WORK.

J. S. R. sends a sketch illustrating how a universal chuck can be used on a drill press for work which requires a boring bar, or for any cylindrical work which is to be drilled or bored. This arrangement has been in use for several years, and has proved to be very satisfactory. The attention of the reader is directed to the stud-plate *A*, which is the principal part of the arrangement. This plate has a projection on the bottom side which is turned to fit the hole in the center of the drill press platen, and a projection on the top side which is bored as large



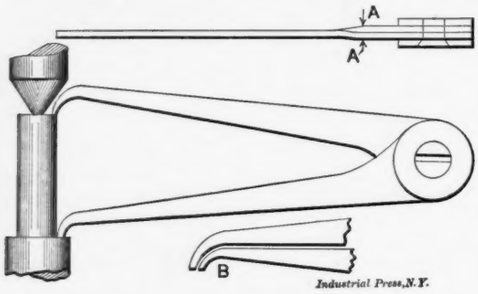
as the conditions will allow, and threaded on the outside to fit the threaded part of the faceplate of a universal chuck. This stud-plate is secured to the drill press platen by two bolts, as shown at *B* and *C*.

The bushing *E* is bored so as to be a good working fit on the boring bar *D*, and made to rotate with the bar by means of a key, which is fast in the bushing, but must slide freely in the keyway in the boring bar. If the boring bar has more than one mortise in it for cutters, the keyway should be cut from the lower end of the bar to the highest mortise. This bushing is turned on the outside so as to be a good working fit in the stud-

plate, and should have a collar as shown at the upper end, which will, to a large extent, prevent dust and fine chips from getting into the working joint. By this arrangement the boring bar is supported at both ends, which insures greater rigidity, increase of feed, more stock removed in a given time, a greater variety of work, and as a consequence, more work done.

HOME-MADE SHOULDER CALIPERS.

V. H. M. sends a sketch of a pair of shop-made calipers which, he writes, have proved very handy in measuring work from shoulder to shoulder or from a shoulder to the end of the piece. For this purpose they are much handier and more

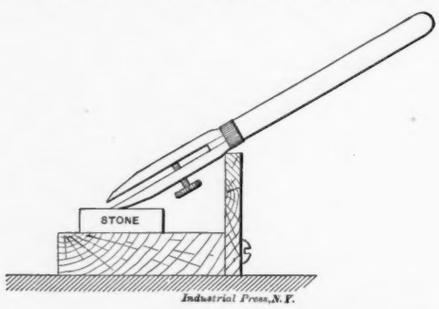


Industrial Press, N.Y.

accurate than the ordinary "hermaphrodites." The legs are bent at *A A* so as to lie flat and thus bring the point of the long leg directly behind the short one which "nests" into it, as at *B*, so that the calipers may be used for short measurements as well as for the long ones.

PEN SHARPENING ARRANGEMENT.

W. T. S. sends a drawing of a little arrangement that should prove very convenient in every drawing room. This is a device which he has used to facilitate the sharpening of drawing pens. A small wooden block, to which is attached a back, is all that is required. The stone is placed in any position desired and moved away from or toward the vertical back in order to bring the pen in contact at any angle that is wanted. The stone is held in place by the left hand,



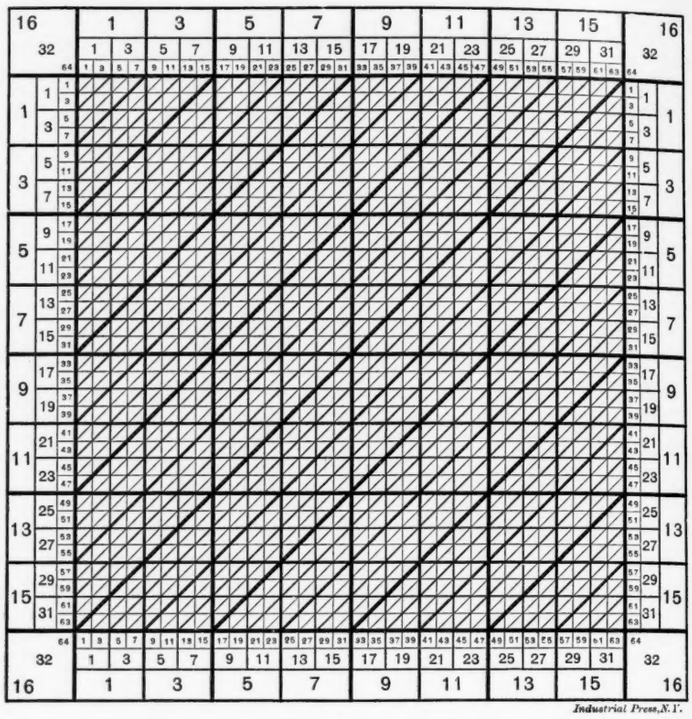
Industrial Press, N.Y.

and the pen, held by the thumb and forefinger of the right hand, is moved backward and forward and at the same time given a rocking motion so as to grind all of the point. In this way first one and then the other nib of the pen are given an ideal finish.

ADDITION AND SUBTRACTION CHART.

L. S. Burbank, Worcester, Mass., sends us a chart that will prove of assistance to draftsmen and others in the addition and subtraction of fractional parts of an inch. The numbers in the smallest rows are 64ths of an inch and in the next larger rows 32ds and 16ths respectively, 8ths and larger fractions being located without indicating. One of the fractions to be added is located on the top of the chart, and the next number located on the left; trace the lines from these numbers vertically and horizontally to their intersection and then follow the intersecting diagonal line to the nearest side. The number there found is the sum of the two fractions. If this sum occurs on the right or bottom side of the chart, 1 must be added to the result. All numbers are traced on the line except 64ths, which, to simplify the chart, are traced between the lines.

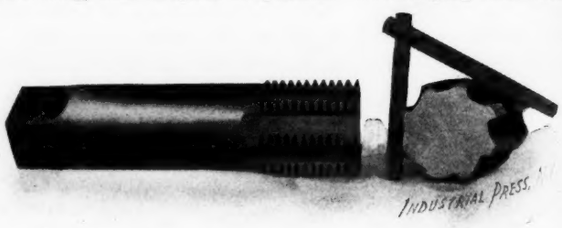
Example: Add 1¼ + 7-32 + 2⅛ + 53-64. The sum of the more easily computed numbers (1¼ + 2⅛) is found by inspection to be 3⅜. Continuing from here, find ⅜ on top of the chart, on third vertical line from the left. Note this point and find 7 in the 32ds row on the left; trace these horizontally and vertically to their intersection and then trace the intersecting diagonal, either way, to the edge of the chart, in this case pointing to 19 in the 32ds row. The result is now 3 19-32, but without stopping to learn this, note the point and find 53 in the 64ths row at the top. Trace similarly to their intersections, then the diagonal to 27, which is found in the 64ths row. As this occurs on the right or bottom of the chart, 1 must be added, making the required sum 4 27-64.


Industrial Press, N.Y.

Any number of fractions may be added without stopping to learn the individual results, very much in the same way in which continuous calculations are performed upon the slide rule. As it does not matter from which side of the chart the numbers are found, the nearest one may be used for convenience. To subtract, trace *diagonally* from the larger number and *horizontally* from the smaller. Then from their intersection trace *vertically* to the same side on which the larger number is chosen.

ANNEALING A TAP.

H. H. E. sends us the accompanying photograph of a tap which was broken during the process of hardening. It was designed for a finishing tap, 4¼ inches in diameter and 22 inches long, and weighed 65 pounds. The forging was made



from a bar of 4¼-inch carbon steel which was upset to a diameter of 4½ inches and thoroughly annealed. It was then machined to finished size without a second annealing but when the attempt was made to harden it, it broke in two, as illustrated. While there may be some difference of opinion as to just what caused this break there is but little doubt that the upsetting of a bar of steel is usually attended with disap-

pointing if not serious results in the finished tool. Where the nature of the work is such as to require that a tool like this be made from the solid bar, too much care cannot be exercised in forging and annealing the steel.

* * *

SPEEDS AND FEEDS.

E. R. MARKHAM.

For many years it has been a matter of study with the writer to harden tools in a manner that made it possible to run them at speeds, and to apply feeds, that insured the maximum amount of product. Many times, however, the matter of speed is given a great amount of attention, while other factors fully as important are lost sight of. I remember visiting a shop at one time where one man was running three lathes on very short cuts. The work being turned was run at a very high rate of speed. The foreman informed me that he had succeeded in getting a steel that would stand up when the work was run at more than double the speed he had formerly considered possible. Observation soon showed that the work was traveling at so high a speed that the entire length of the machined portion was traversed some little time before it was possible for the operator to tend to the other machines and get back to this one. Of course I realized that the proper method to pursue would have been to run the lathes at as high a speed as possible and then have sufficient help to take care of them as soon as the cut was across; provided there was enough work to keep all hands busy. But if an extra man had been provided there would not have been enough for either of them, so it was advisable to let one man do it all, and have him get around as rapidly as possible. The question naturally arises "Why run at such extremely high speed and have to wait at the end of cut?" As much work would have been accomplished had the speed been gaged so that the cut would be completed just before the workman got around; and the tools would have stood up much longer. The bearings on the machine would not have worn out as rapidly, neither would it have taken as much power to run.

The number of feet per minute at which a cutter runs should not be the only thing taken into consideration, but also the speed at which it is necessary to run the cutter—or the stock as the case may be—in order to produce the maximum amount of work possible on a machine, in a given length of time. A shop owning a large number of milling machines considered installing enough more to enable them to increase their product 50 per cent. They were advised, instead, to harden their cutters by a process entirely different from that which they were using, with the result that they were able to speed their machines up and get from their equipment the desired increase in output without the extra expense of *new* equipment. When it is possible to increase the amount of work turned out by a machine by increasing the speed, it should be done, provided, it *will* increase the output of the machine; but if the increased speed necessitates grinding the cutters so often that the output is curtailed rather than increased, then it is folly.

To enable them to run at high speed, some shops harden their tools by methods that insure the desired results. When speeds greater than it is possible to obtain with ordinary carbon steels are desired, it becomes necessary to use the high-speed steels. The various high-speed steels can be procured in almost any form—either in the shape of bars, blocks, or blanks for milling machine cutters. They can be obtained in the annealed state, so they can be machined to shape very readily, or they may be annealed on the premises.

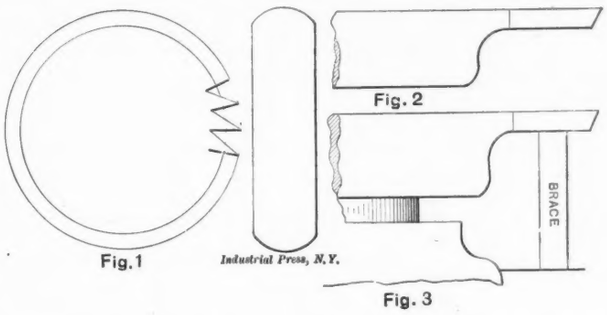
Many times a *high speed* is used to turn out an increased amount of work when the result might have been attained by the use of *coarser feeds*, and the cutters would have retained their edge much longer. It is a mistake oftentimes to feed *too* slowly.

While the matter of increased feeds is being treated there are several things that must be considered. First, the strength of the machine must be taken into consideration; then the strength of the arbor—if the machine be a milling machine; the strength of the cutting portion of the tool, and whether it will be able to resist the additional strain without breaking or springing; the ability of the piece of work or the fixtures holding it to resist the added pressure, etc. A lathe tool if made of light stock or if the cutting portion is too light, will not turn a piece of steel having an irregular surface true if heavy cuts or feeds are used. A milling machine cutter whose teeth are too light cannot be subjected to coarse feeds, for the teeth will spring, dig into the surface of the work, and probably catch and break. A milling machine cutter, or similar tool, whose teeth are too fine cannot be given a coarse feed, as the spaces between the teeth do not furnish sufficient room for the chips; and again, being filled with chips the lubricant cannot get to the teeth, so they will heat and dull very quickly.

The writer recalls an instance of a milling machine cutter of the form shown in Fig. 1 which had 42 teeth. The cutter was 3½ inches in diameter, and was used in milling a handle bar binder for a bicycle. It was not possible to mill more than 20 or 22 of these pieces in a day. A *formed* cutter having only 9 teeth was made and it was found that 120 pieces could be milled per day on the same machine. The difference in results was due to the much heavier feeds it was found possible to use when the cutter teeth were strong and there was sufficient room for the chips and lubricant.

Sometimes a forming cutter for use in a lathe or screw machine is made very light as shown in Fig. 2. To produce a smooth cut it is found necessary to run the machine very slowly, and to support the tool as shown in Fig. 3, possibly even to do both, *i. e.*, to run slowly and support the tool. Now were the tool made sufficiently stiff it would not be necessary to run as slowly and it could be fed much faster.

Reamers and taps are oftentimes made with the teeth or lands so weak that it is found impossible to do a satisfactory



amount of work with them. In the case of a tap, the lands when light will spring and consequently open out into the work, unless it is handled very carefully. And the operator is obliged to turn but a very little, then back out a little, and so continue doing until the hole is tapped, which is very slow work, and generally very unsatisfactory. A reamer whose teeth are light is also a source of much annoyance, as only the finest feeds can be used or the teeth spring out, gouging into the work, break the reamer teeth and produce a ragged, uneven hole. It is of course necessary in the case of a tap or reamer to provide sufficient space for the chips, and to give a chance for the lubricant to get at the cutting edges, which can be done by properly designing the tooth.

While the design of the cutting tool has much to do with its success, yet it cannot possibly do the amount of work it should unless properly hardened. If steel is not given the proper heat when hardened it is not in a condition for running at a high rate of speed; and if it is overheated the tool is weak—and if subjected to coarse feeds, the cutting portion will break.

Tools made of carbon tool steel are capable of higher speeds if hardened by the method known as "Pack Hardening;" then again, being much stronger, they are capable of resisting coarser feeds than if hardened by the ordinary methods.

In these days of competition, when speeds and feeds are a matter of vital importance, every phase of the subject must be considered to get the most possible work. It is of course possible to accomplish *something* on a machine that is too light for the purpose, but much more can be accomplished if the machine and tools are adapted to the work in hand. The modern high-speed steels are doing a great deal to revolutionize shop practices, yet much better results can be obtained with carbon steels than is often the case.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

6. R. M. S.—In making a peculiar form of self-oiling, babbitted journal box, we wish to core an oil pocket between the cast iron box and the babbitt shell. Have tried to use a sand core, but without success, owing to the shape of the pocket. Is there anything that can be used for a core in such a place?

A.—For work of this kind a core made of common beeswax will be found to work very satisfactorily. By warming it gently it can be formed into any shape desired. When the babbitt is poured it hardens so quickly that the wax does not have time to melt, so that a perfect core is formed. The wax can then be removed by slowly heating the box and pouring it out as it melts, care being taken not to heat the box hot enough to melt the babbitt.

7. F. R. H.—To run a 20 horse power motor on 220 volt circuit according to the maker's catalog requires 85 amperes. Figuring this by the formula given in Kent's Mechanical Engineers' Pocket Book, H. P. $= \frac{\text{Volts} \times \text{amperes}}{746}$ it should require about 68 amperes. Is the motor rating or the formula at fault?

A.—The formula to which you refer does not take into consideration the efficiency of the motor, which is generally but 75 to 80 per cent. of the result obtained by the formula as given. For practical purposes the formula should read H. P. $= \frac{\text{Volts} \times \text{amperes}}{746} \times f$, in which f = the efficiency of the motor. Suiting this to your case and allowing an efficiency of 80 per cent. we have:

H. P. $= \frac{220 \times 85}{746} \times .80 = 20$, which agrees with your rating.

8. A. E. H.: Will you please explain what is meant by "Eastern" hose thread, "California" thread and regular hose thread? Please give table of standard of sizes and pitch of threads.

A. We are informed by the Allen Fire Department Supply Co., Providence, R. I., that hose threads, in use by the fire departments of the different cities, all vary more or less, hardly any two in the country being exactly the same. For example: New York has a standard of its own, which is 8 threads to the inch; Providence has one of 7½ threads per inch; while Raleigh, N. C., has 6 threads per inch, 3 5-16 inch outside diameter. Burlington, Vt., has 2½ × 3 threads, and San Francisco and Sacramento, Cal., have 2½ × 7½ threads, but this is not the same as the Providence standard, which has the same number of threads but a different outside diameter. The same discrepancy also applies to the threads used on the smaller sizes of hose, such as garden hose. Thus it is impossible to present a table of hose threads that could be considered in any way as representing any generally adopted "standard."

9. G. C. N.: In cutting a spur gear for a pattern, when it is desired to cut the space wider than the thickness of the cutter, would it be correct, after the cutter has been once through the blank, to turn the blank so as to take the entire amount of extra cut from one side of the space; or should it be turned first forward and then backward and an equal amount of stock cut from each side of the space? The idea being to keep the shape of both sides of the space alike. 2. Does it materially change the shape of the tooth to set over the dividing head one or two holes?

A. The former method, that of removing all of the stock from one side of the space, would be the only practical way to cut the pattern teeth. By taking one-half of the amount of the metal from each side of the space we would obtain exactly the same results but more work would be entailed. The cutters, as made, will cut the correct form of tooth only when their center line is in line with that of the blank and so long as this condition is fulfilled it makes no difference with the shape of the teeth forming the sides of a space, whether stock is taken from one side or both. 2. Setting over the dividing head one or two holes would only turn the blank on its center and would not affect the position of the blank center as regards that of the cutter, consequently the form of the tooth would not be changed otherwise than to be thinner than standard by the amount that the blank was turned.

* * *

DRAWING WORM THREADS.

Regarding the method for drawing a 29-degree thread that was described in answer to question 2 of the "How and Why" department, "Draftsman" writes: While this method is, of course, perfectly correct I have found the method described in Brown & Sharpe's "Treatise on Gearing" to be much more convenient to use. To draw the sides of a 29-degree thread by this method, upon a horizontal line $A\,A$ draw a semicircle with any convenient radius. Then from the point B, where the semicircle intersects the line $A\,A$, draw an arc with a radius equal to one-half that with which the semicircle was

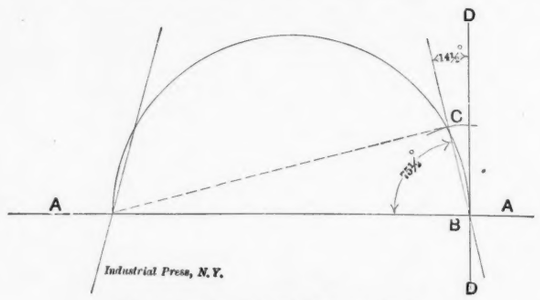


Fig. 1. Laying Out 75 1-2 Degree Angle.

drawn and this intersects the semicircle at the point C. A line drawn through the points C and B will make an angle with the line $A\,A$ of 75½ degrees and consequently with the vertical axis $D\,D$ it makes the required angle of 14½ degrees, which is the angle of the side of the worm or "Acme" thread tooth.

In proof of this method, in the triangle $A\,B\,C$, $A\,B = 4\,C\,B$, by construction, and the angle $A\,C\,B$ is a right angle since it is inscribed in a semicircle, consequently the cosine of the angle $A\,B\,C = ¼ = .2500$. The cosine of 75½ = .2504, so that this method is seen to possess the same degree of accuracy as that previously described.

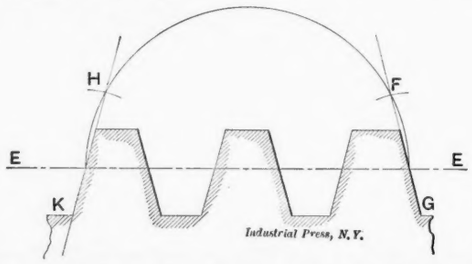


Fig. 2. Application of above Method to laying Out 290° Threads.

In drawing the teeth of a worm or an "Acme" standard thread this method is conveniently applied, as illustrated in Fig. 2. Here the semicircle is drawn on the pitch line $E\,E$ with a diameter equal to the distance from the front of one tooth to the back of another. Then when the lines $F\,G$ and $H\,K$ are drawn, by the above construction, they will form respectively the right- and left-hand faces of the thread teeth. It is then an easy matter to draw the faces of the other teeth from these by the use of the triangle and T-square.

* * *

Errata: According to the present common acceptation of the term in the United States, the expression "diametral pitch" was incorrectly used in the answer to "F. H.," Question 30, August issue. It should be changed to read "diameter pitch."

In the answer to question 33, in the same issue, in the formula by Prof. Carpenter for the flow of steam through pipes, the denominator of the equation should read 7,500 Dd^5 instead of 7,500 Dd^2 as there printed.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

STOCKBRIDGE ELECTRICALLY-DRIVEN SHAPER.

We illustrate herewith, in Figs. 1 and 2, a new electrically operated shaper which is the product of the Stockbridge Machine Co., Worcester, Mass. This shaper has a stroke of 24 inches, is back-geared and has a 4 to 1 quick return stroke. The ram is driven by a combination crank motion, which is a new and very powerful mechanical movement and gives an even cutting speed throughout the entire length of the stroke. Especial attention has been paid to the packing for the ram, and the taper packing which has been adopted does away with packing screws and makes it impossible for the ram to get out of alignment. The length of the stroke may be readily changed from the front of the machine and is indicated by an index and pointer so placed as to be in plain view. The head has a travel of 9 inches, and is fitted with a very simple automatic feed operated by an adjustable dog and pawl shown on the side of the machine in Fig. 1. The feeding is done at the end of the return stroke, so that the tool is not dragged back over the scale nor does it require any great amount of clearance to feed in. The length of the feed at each stroke can be readily adjusted to suit the work.

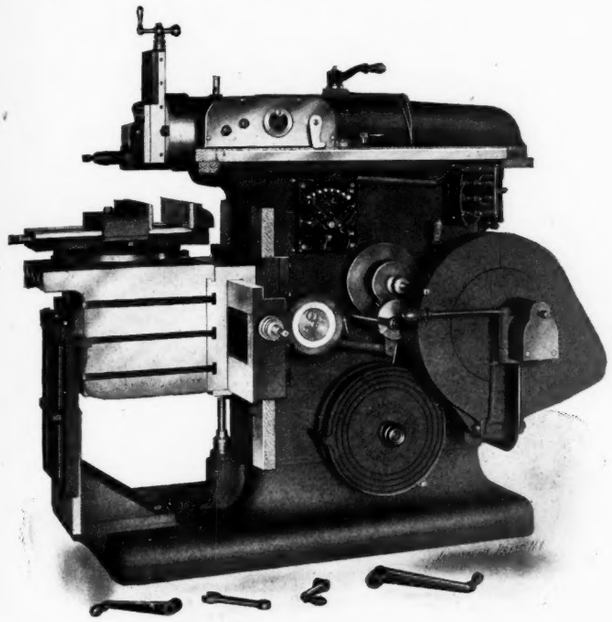


Fig. 1. Stockbridge Shaper with Motor Drive.

The table has a vertical motion of 15 inches and is operated by bevel gears and double screw so that it becomes unnecessary to cut any hole in the floor for the screw to pass through, thus permitting the machine to be set on concrete floors. Ball bearings are employed to facilitate the operation of the elevating screw. The cross-feed is 30 inches in length and automatic in either direction. It is operated through a rod which adjusts itself to any position of the bar, and the screw is fitted with a graduated collar reading to 64ths inch, the same as the down-feed screw.

The machine is operated by a 3 horse power Storey motor, which, by means of rheostat speed controller, may be made to impart a driving speed to the machine varying through a range of 300 per cent. The power is transmitted from the motor to the machine by means of a Morse flexible chain, which provides a quiet and positive driving mechanism that has proved very satisfactory. The shaper is started and stopped while the motor is still running, by means of the clutch lever which is placed at the outer end of the driving shaft. The levers for operating the back gearing, changing length of stroke, feeds, etc., and the switch for starting and stopping the motor, together with the speed controlling mechanism, are all placed where they may be easily reached by the operator without leaving the position ordinarily occupied when running the machine. A circuit breaker, mounted on the back of the column, is shown in the rear view, Fig. 2.

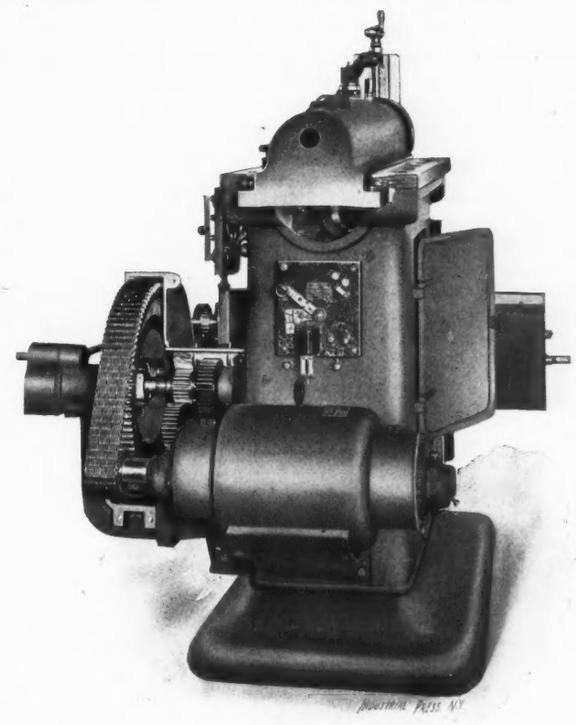
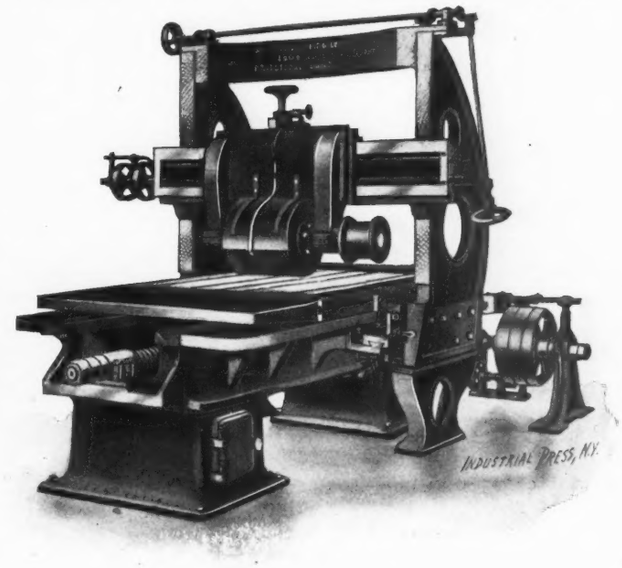


Fig. 2. Rear View of Stockbridge Shaper, showing Motor.

"SPRINGFIELD" SURFACE GRINDER.

The Springfield Manufacturing Co., Bridgeport, Conn., have added to their line of grinding machines the surface grinding machine that is illustrated in the accompanying half-tone. This will be known as their No. 7 surface grinder. The machine shown in the illustration is designed for surfacing work



"Springfield" Automatic Surface Grinder.

5 feet long by 4 feet wide and is adapted for grinding one large surface or several small surfaces at one time. This grinder is especially constructed for the use of water, which is believed by the builders to be a prime factor in rapid and accurate surface grinding. The bed and platen are provided

with proper aprons to confine the water to the machine, and there are also receptacles in which the water settles before being forced back onto the wheel by the rotary pump. The carriage is operated by a leadscrew, the power being transmitted to the same by a worm and worm gear which has proved very effective in overcoming any chattering.

The emery wheel, which is 16 inches in diameter and has a 16-inch face, oscillates across the platen between the housings while the platen is passing under it. By these two distinct motions the wheel covers the entire surface very quickly and produces the diagonal or file cut which avoids tearing up the fine fibers of metal, as is sometimes the case when the wheel runs parallel to the work. This oscillating motion has also the advantage of keeping the wheel uniform by its own operation. By a simple attachment the oscillating device can be thrown out at any point that the operator may desire, admitting of grinding close to a shoulder should the nature of the work demand. The cross rail carrying the wheel head is easily adjusted by a hand wheel which is connected with the elevating screws by the use of bevel gears. The wheel head has also a micrometer adjustment allowing the wheel to be adjusted to one-quarter of a thousandth of an inch. An idler is provided to automatically adjust the belts on the emery wheel and cross rail. The builders of this machine are prepared to furnish it for any desired capacity, from 2 feet long by 14 inches wide up to 20 feet long by 10 feet wide

BECKER-BRAINARD PLANER TYPE MILLING MACHINE.

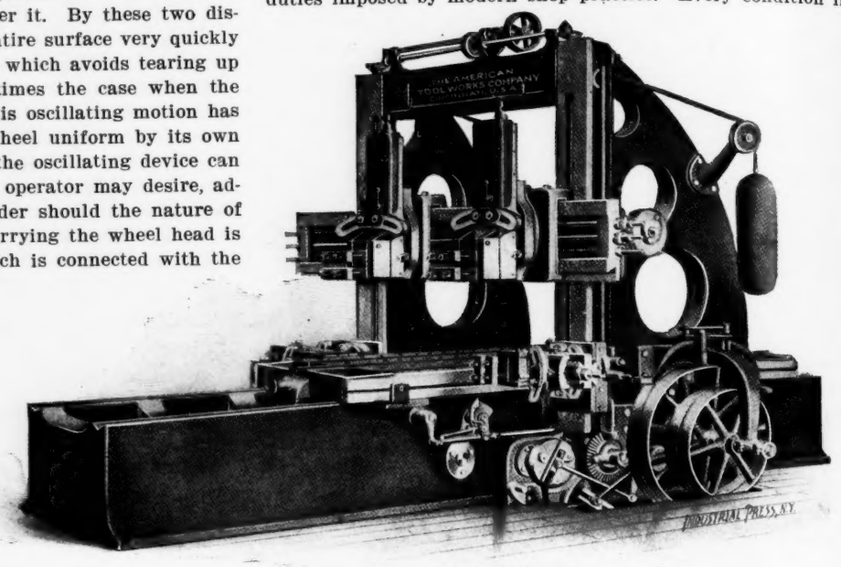
The Becker-Brainard Milling Machine Co., Hyde Park, Mass., have just added to their line of milling machines the 32-inch x 26-inch x 10-foot planer-type machine that is shown in the accompanying half-tone. This machine is designed for strength, rigidity and power, with special provisions for ease of operation and the demands of modern milling machine practice. The crucible steel spindle, which is 5 inches in diameter, has a threaded nose and runs in self-centering boxes with nut and check nut to compensate for wear. The spindle carrier is held firmly to the upright by long gibs and is elevated by a screw with adjustable dials graduated to thousandths of an inch. It is provided with a counterbalance for ease of operation. There are 20 changes of speed for the cutter spindle obtained by gearing in the main driving cone, operated by clutch and lever so that all changes can be made instantly.

The table is provided with five longitudinal T-slots, and has an oil channel the full length and at each end. It travels on flat gibbed ways, and has a quick return operated from a separate countershaft. It can also be moved by the usual hand wheel. The platen has a working surface of 120 x 26 inches, with a longitudinal feed, automatic in either direction, of 120 inches. The feed of the table is operated through gearing from the spindle by means of a belt running on a five-step cone and giving a range of feed, through eight changes, from 3-64 to ⅜ inch. The changes of feed can be effected instantly by a lever, without stopping the machine.

The head may be adjusted in either direction from either side of the machine so that it is not necessary to take the cutters off from the arbor in order to change their position in relation to the work. The greatest distance from the center of the spindle to the table is 28 inches and the least is 2 inches. The bed is of extra depth, extending to the floor and making a solid foundation. It can be made of any length desired. The weight of the machine, with the 10-foot bed, is about 25,000 pounds.

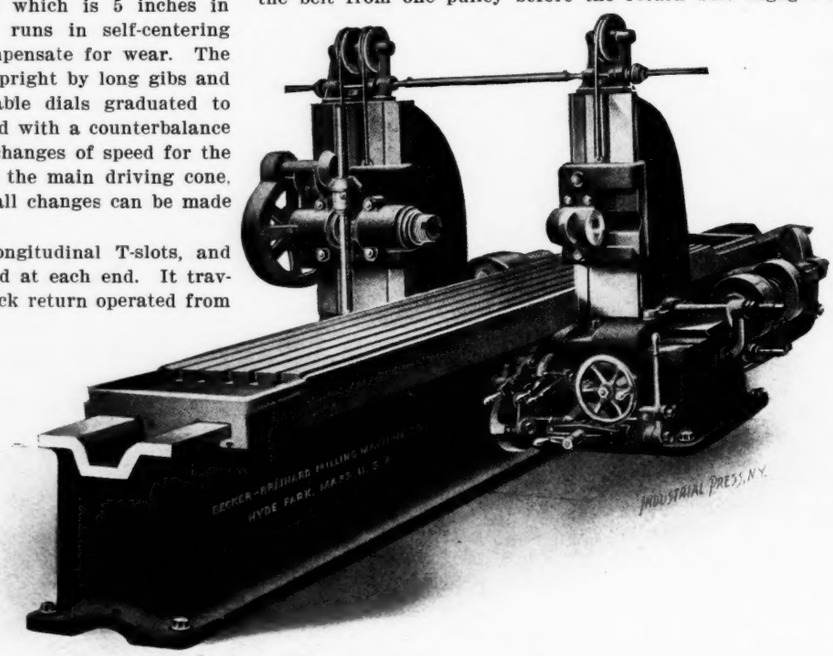
NEW "AMERICAN" PLANERS.

The American Tool Works Co., Cincinnati, Ohio, have thoroughly redesigned their entire line of planers, from 22 to 48-inch sizes, with the purpose of adapting them to the increased duties imposed by modern shop practice. Every condition influencing modern planer work has been given careful consideration with a view to increasing the efficiency of the machines and adapting them to the use of high-speed steels. Strength and rigidity being the foremost aims, the bed has accordingly been made very heavy and of unusual length in proportion to the table, so that there will be but a slight overhang of the table when planing to full length.



"American" 48-inch Planer.

The table has a new shifting mechanism which reverses the belt from one pulley before the return belt engages the other, thus obviating any disagreeable shrieking of the belts. A safety locking device prevents the table from starting before the operator is ready, while it may be easily run from under the tool for an examination of the work. The housings are of the double-webbed cored-section type, with wide bear-



Becker-Brainard Type Milling Machine.

ings for the cross rail which is raised and lowered rapidly by power. The heads on the rail are made right and left to permit them to work close together, and the saddles are graduated for angular planing.

The feeds are all automatic and can be operated from either side of the machine. The down feed is of exceptional length and equipped with micrometer adjustment. The side heads are of the compound slide type, are counterbalanced and can be run below the level of the table when not in use. Each shaft is so arranged that it can be readily removed, when necessary, without disturbing the rest of the machine, and all of the gearing is located on the inside of the bed.

THE MOTOR-DRIVE AS APPLIED TO MILLING MACHINES.

Figs. 1 and 2 illustrate one of the latest steps in the adaptation of the electric motor to the purpose of machine tool operation. These milling machines, made respectively by the Brown & Sharpe Mfg. Co. and the Cincinnati Milling Machine Co., are operated by Crocker-Wheeler shunt-wound motors. The regulation of speed is obtained by the use of a Crocker-Wheeler, 12-point controller, designed to operate on a 4-wire multiple voltage system of current supply, and gives six speeds by voltages ranging from 40 to 240, by steps of 40 volts each. An equal number of intermediate speeds is secured by the use of resistance, giving in all 12 speeds in either direction.

The motor is located directly over the machine, where it is enabled to drive the spindle at a point between the bearings, and at the same time it in no way increases the amount of

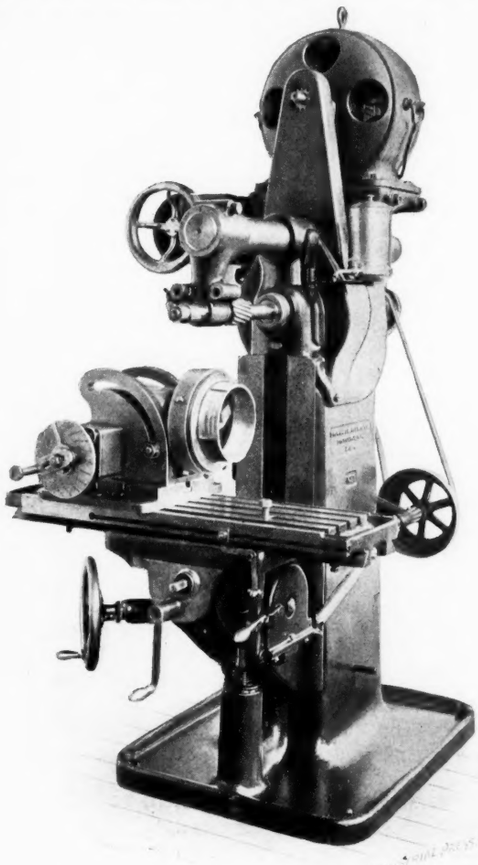


Fig. 1. Brown & Sharpe Milling Machine with Motor Drive.

floor space occupied. Power is transmitted from the motor to the spindle of the machine by a Morse rocker-joint chain which is much more satisfactory than a belt, owing to the extremely short distance between the centers of the shafts. In its operation the chain is positive and noiseless, and the pull exerted between the motor shaft and the spindle is only that necessary to transmit the power required. The sprockets and the chain are entirely encased in light guards which are easily removed when necessary, but which normally protect the chain from dirt and the workman from injury.

The Brown & Sharpe machine, being designed for light work, is fitted with a 3 horse power motor, which is connected to the spindle of the machine by a speed reduction of about 3½ to 1. The highest speed of the motor drives the spindle at 276 revolutions per minute, and the slowest speed at 44. The height of the machine and motor over all is but 6 feet 4 inches, so that the motor is readily accessible for adjustment or examination.

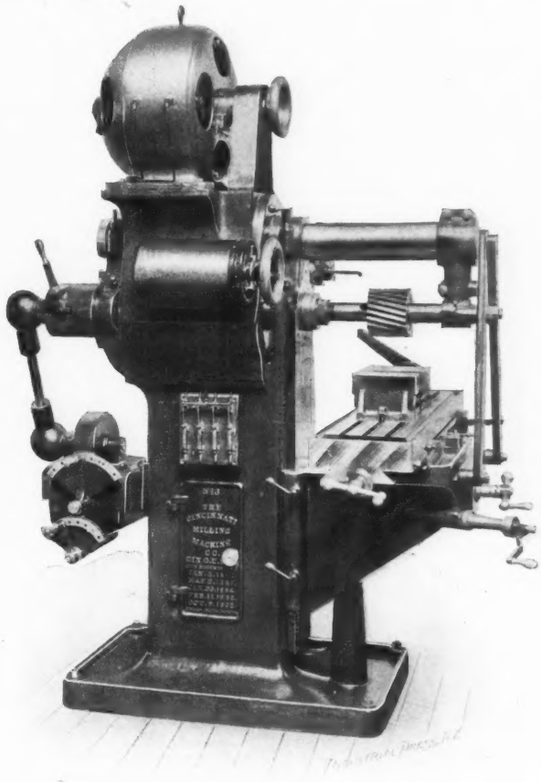


Fig. 2. Cincinnati Milling Machine with Motor Drive.

The Cincinnati machine is built for rather heavy service, and is fitted with a 7½ horse power motor. This machine is provided with a powerful feed changing mechanism, covering an exceptionally wide range. Sixteen feeds are available, and they may be changed instantly from one to another without stopping the machine and regardless of the speed of the spindle. Beside the 12 different speeds secured by the motor, 24 more may be obtained by the use of back gear combinations. The greatest available speed of the spindle is 278, and the least 14 revolutions per minute. The hand wheel, shown on the extension of the motor shaft, is for turning the motor by hand when the power is shut off, so as to permit the teeth to intermesh when changing the back gear combinations. All gears, chain, or other dangerous moving parts are carefully inclosed and every precaution has been taken for the protection of the operator against accident.

NEW CLAMPING DEVICE FOR MICROMETER CALIPERS.

The Brown & Sharpe Mfg. Co., Providence, R. I., have recently placed upon the market an improved device for clamping the spindle of micrometer calipers, which is very simple and efficient, a slight movement of a knurled nut being all that is required for clamping the measuring spindle firmly. After a measurement has been taken it is often desirable to lock the spindle to retain the measurement, and it is important that the spindle should not be rotated or moved longitudinally in order that the original measurement be not altered. The construction of this device is such that the possibility of disturbing the adjustment is entirely avoided. Its general appearance, as applied to the calipers, is shown in Fig. 1, on next page, while the details of its construction are clearly illustrated by the drawings in Figs. 2 to 5, the operation of the mechanism being as follows: The split ring, *B*, Fig. 2, fits the measuring spindle with a sliding fit when open, thus insuring a longer bearing for the spindle than has been pos-

sible with the devices heretofore used for this purpose. The ring is held firmly from rotating by the lug, *D*, which fits into a recess in the slot, *K*, Fig. 5. The roller, *C*, Fig. 2, which moves upon the inclined surface cut in the periphery of the ring, is actuated by the ring, *A*, Fig. 3. The clamping ring, with the roller at the lowest point, fits into the ring, *A*,

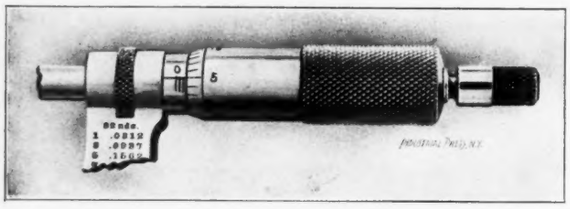


Fig. 1. Clamping Device for Micrometer Calipers.

with a sliding fit; and as the clamping ring is held from rotating, the movement of the actuating ring, *A*, to the right forces the roller up the inclined surface, *E*, and closes the ring concentrically around the measuring spindle. The slot in the caliper frame, Fig. 5, receives the two rings together with the roller, and the spindle is passed through the clamping

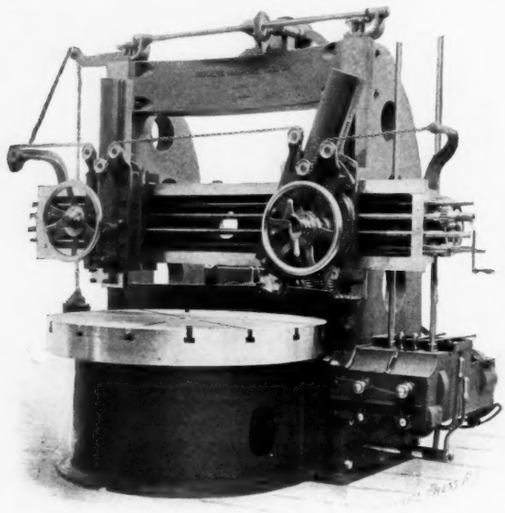
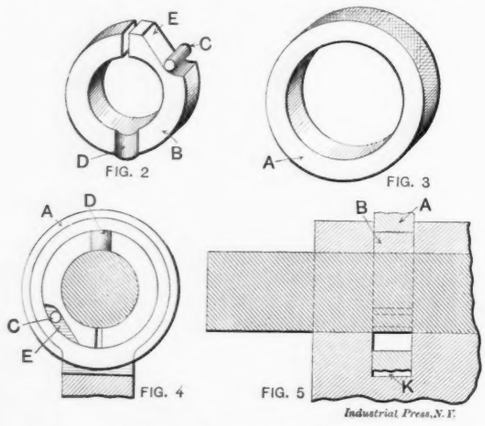


Fig. 1. Rogers Boring Mill—Front View.

ring. It will be seen that as the clamping ring closes concentrically there is no opportunity for dirt or grit to get into the device, and spindle cannot be thrown out of alignment when clamping. The clamping ring cannot be taken out of the frame until the spindle has been run out sufficiently to clear the recess, and this prevents the device from being ac-



Details of Micrometer Clamp.

cidentally lost, as is many times the case with a nut and split bushing that fits over the end of the spindle.

Another new feature of this device is that the tension of the measuring spindle can be adjusted without disturbing the threaded portion of the screw and nut. This is a valuable feature when measuring a number of pieces for comparison, as sufficient tension can be put on the spindle to prevent its turning when the work is passed between the measuring points and at the same time the spindle can be left sufficiently free to allow of slight adjustments. When the clamping ring has been set to exert a certain tension, the rotation of the spindle cannot alter it, for the reason that the clamping ring is held stationary and forms part of the bearing of the spindle.

ROGERS BORING AND TURNING MILL.

The accompanying photographs, Figs. 1 and 2, show the front and rear view of a 62-inch boring and turning mill built by the Rogers Machine Tool Co., Alfred, N. Y., who have entirely redesigned their line of these machines in order to meet the demands of modern boring mill practice and qualify them for the use of high-speed steel. An important feature of this machine is the fact that it can be changed from belt to motor drive at a very small expense, as the driving arrangement is composed of a cluster of gears that are so proportioned as to give a great range of speed and large number of speed changes. The change is accom-

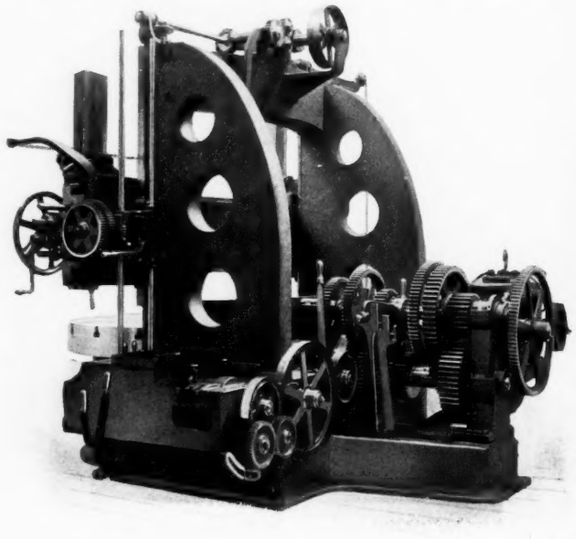


Fig. 2. Rogers Boring Mill—Rear View.

plished by replacing the driving pulley with a gear, which is shown in the rear view, Fig. 2. In this case the motor is mounted on a bracket securely fastened to the frame.

The table is supported by a spindle with V-shaped bearings of large diameter, and the foot brake, which is one of the features that have been retained from the earlier machines, enables the operator to stop the table in any desired position. The cross rail has a belt lift so arranged that only the pulley shaft need be run when raising or lowering the rail. Positive gear feeds are used, which are operated by levers, and each head is independent in amount and direction of feed. The feeds are easily operated, the levers being convenient to the operator's hand. The machine can, at any time, be fitted with screw cutting or drum grooving attachment.

THE "CHICAGO" ADJUSTABLE BORING TOOL HOLDER.

The "Chicago" adjustable boring tool holder has been designed to meet the demand for a holder for use with self-hardening tool steels, and one that shall be quickly adjustable to the different sizes of lathes upon which it may be used. In using this holder the tool post is removed from the lathe and the holder clamped to the cross slide. This provides, in reality, two tool posts five inches apart which furnish a very rigid support for the boring bar. The bar itself is secured in the holder by two clamps, operated by setscrews, and the cutter can be swung to any desired height at which it is clamped by a setscrew on the side of the holder. The form of clamp used for holding the bar, together with the provision for adjusting the height of the cutter, permit the use of any size of bar within the limits of the holder.